ParaSoft®
codewizard®

User's Guide

Version 3.2
WINDOWS

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Introduction

Welcome to CodeWizard, a unique C/C++ tool that prevents errors by automatically enforcing built-in and custom C/C++ coding standards.

Coding standards are language-specific rules that, if followed, will significantly reduce the opportunity for you to make errors. When you implement and enforce coding standards for every project every day, you can prevent errors from entering code and greatly reduce the amount of debugging that you must perform to find and fix errors after they have been introduced.

CodeWizard automatically enforces C and C++ coding standards to help you prevent errors and make your code more portable and maintainable. CodeWizard is an automatic source code analysis tool based on programming ideas from C and C++ experts. CodeWizard enforces over 170 built-in C/C++ coding standards, and any number of custom C/C++ coding standards that you create with RuleWizard, a CodeWizard feature which lets you graphically create your own coding standards or customize existing CodeWizard coding standards.

If you develop software for embedded systems, CodeWizard can help you prevent errors before your code leaves the host system. CodeWizard enforces a set of coding standards designed specifically to prevent errors in embedded software development; it also lets you easily create and enforce your own embedded development coding standards.

Installation

To install CodeWizard, run **cw_win.exe** or **cw_win_jre.exe** from either the command line or from Windows Explorer.

If you have Visual C++ installed on your system, CodeWizard will install itself automatically into Microsoft Visual C++. The Visual C++ Tool menu will contain the following tools:

- Analyze File
- Analyze Modified
- Analyze All
- Launch CWPanel
- Launch Insra
- Launch RuleWizard

These commands will also be represented on the CodeWizard tool bar which will appear automatically in Visual C++.

After you enter your password, you will be ready to begin using CodeWizard.

Entering Your Password

Once you install CodeWizard, you need to enter a password and expiration date before you can begin using the tool.

To receive your password and expiration date, call ParaSoft at **1-888-305-0041 x 4.**

You will need to give your **Machine Id** information to the representative in order to receive your password and expiration date.

Once you receive your password and expiration date, you need to enter them into the Password tab of the CodeWizard Control Panel.

You can open this panel in any of the following ways:

- Click the **Launch CWPanel** tool bar button in Visual C++.
- Choose **Tools> Launch CWPanel** in Visual C++.

- Choose **Start> Programs> CodeWizard> CodeWizard Panel**.

Once the CodeWizard Control Panel is open, enter your password and expiration date in the **Password** and **Expiration date** fields of the Password tab, then click **OK**. You can now begin using CodeWizard.

Contacting ParaSoft

ParaSoft is committed to providing you with the best possible product support for CodeWizard. If you have any trouble installing or using CodeWizard, please follow the procedure below in contacting our Quality Consulting department.

- Check the manual.
- Be prepared to recreate your problem.
- Know your CodeWizard version. The number and date of your version can be seen in the About tab of the CodeWizard Preferences Panel.
- If the problem is not urgent, report it by e-mail or by fax.
- If you call, please use a phone near your computer. The Quality Consultant may need you to try things while you are on the phone.

Contact Information

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Using CodeWizard: a Simple Example

You use CodeWizard by processing your source code with the special `codewizard` program in place of your normal compiler. CodeWizard will then call your compiler and proceed as usual.

While processing your code, CodeWizard will detect and report various violations of good C/C++ programming practices, such as:

- Using `new` and `delete` instead of `malloc` and `free`.
- Not calling `delete` on pointer members in destructors.
- Not making destructors virtual in base classes.
- Avoiding breaks in for loops.
- Not comparing chars to constants out of char range.
- Avoiding assignment in if statement condition.

By default, CodeWizard sends its messages to the Insra GUI. For more information on using this GUI, see “Insra” on page 45. You can also have CodeWizard send its messages to `stderr`, `stdout`, or a report file.

The easiest way to learn how to use CodeWizard is to use it on an example program and see what it does. This section introduces one of the examples supplied with CodeWizard.

A Simple Example

To get started, open Developer Studio, then open the item11SV.cpp file (located in <CodeWizard Install Dir>/examples).

Compiling and Running Without CodeWizard

Once you have opened this file, you can compile it and run it in the normal manner.

The program doesn't crash and doesn't print any error messages. However, this program has a serious problem in its coding structure.

Running CodeWizard

You can now run CodeWizard on this simple example to see how a violation is reported.

If you are using Visual C++, you can run CodeWizard on the file by opening the file, then clicking the **CodeWizard Analyze File** button or choosing **Tools> Analyze File**.

If you want to run CodeWizard from the command line:

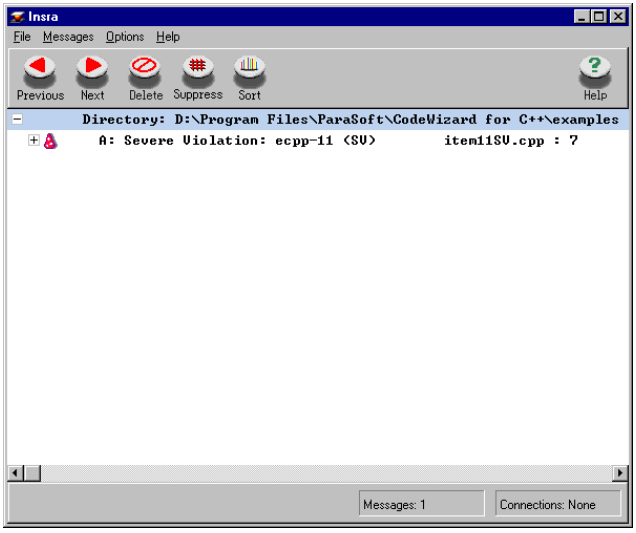
1. Set your path by using a command like:

   ```
   set PATH=c:\Program Files\ParaSoft\CodeWizard
   for C++\bin.Win32;%PATH%
   ```

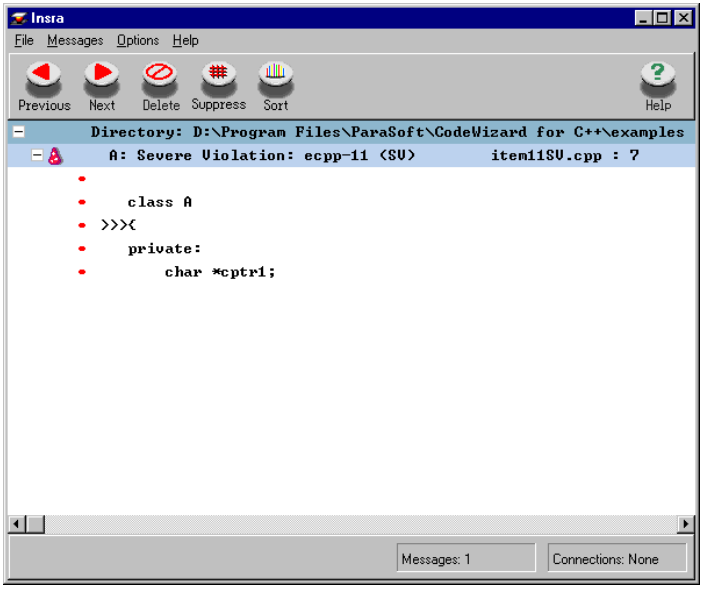
2. cd to <CodeWizard Install Dir>/examples.
3. Type

   ```
   codewizard item11SV.cpp
   ```

CodeWizard will then analyze the code for violations and report the following message in Insra:

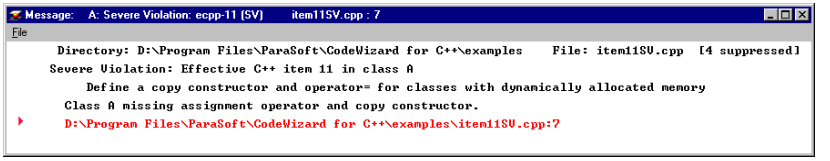

Insra
File Messages Options Help
Previous Next Delete Suppress Sort Help
Directory: D:\Program Files\ParaSoft\CodeWizard for C++\examples
A: Severe Violation: ecpp-11 (SV) item11SV.cpp : 7
Messages: 1
Connections: None

Clicking the ‘+” sign next to the message header will reveal the source code where the violation occurs.



Double-click the message header to open a Message window containing:

- The line of source code where the violation occurred.
- An explanation of the violation detected.


Message: A: Severe Violation: ecpp-11 (SV) item11SV.cpp : 7
File
Directory: D:\Program Files\ParaSoft\CodeWizard for C++\examples File: item11SV.cpp [4 suppressed]
Severe Violation: Effective C++ item 11 in class A
Define a copy constructor and operator= for classes with dynamically allocated memory
Class A missing assignment operator and copy constructor.
D:\Program Files\ParaSoft\CodeWizard for C++\examples\item11SV.cpp:7

To make immediate corrections to the source code, double-click the excerpt of code shown in Insra, or click the arrow in the Message window. This will open the associated file in your selected editor

Using CodeWizard

Running CodeWizard From the Visual C++ IDE

Analyzing a Single File From the Visual C++ IDE

The Analyze File command analyzes a single file. When this command is used, CodeWizard will process the selected file, then display information about the file and the number of errors found. This command is particularly useful in the design and early coding stages.

To analyze a single file from Developer Studio, follow these steps:

1. Open the file that you want to check in Developer Studio.
2. Click the **Analyze File** button, or choose **Tools> Analyze File**.

Analyzing Modified Files From the Visual C++ IDE

The Analyze Modified command makes it easier for you to analyze only the files in your project that have changed since the last time they were compiled. When this command is used, CodeWizard will process each file in turn, and will display information about the files checked and the number of errors found. The Analyze Modified command allows you to save time by analyzing only files into which new problems may have been introduced.

To analyze modified files from Developer Studio, follow these steps:

1. Open the project that you want to check in Developer Studio.
2. Click the **Analyze Modified** button, or choose **Tools> Analyze Modified**.

Analyzing All Files From the Visual C++ IDE

The CodeWizard Analyze All command makes it easier for you to analyze all of the files in your project with CodeWizard at once. When this com-

mand is used, CodeWizard will process each file in turn, then display information about the files checked and the number of errors.

To analyze all files from Developer Studio, follow these steps:

1. Open the project that you want to check in Developer Studio.
2. Click the **Analyze All** button, or choose **Tools> Analyze All**.

Running CodeWizard From the Command Line

Analyzing a Single File

To analyze a single file from the command line, follow these steps:

1. Set your path by using a command like:

   ```
   set PATH=c:\Program Files\ParaSoft\CodeWizard
   for C++\bin.Win32;%PATH%
   ```

2. cd to the directory that contains the example you want to analyze.
3. Type

   ```
   codewizard filename.cpp
   ```

Analyzing the Files in Your Makefile

To analyze the files in your makefile (foo.mak), enter

```
nmake -f foo.mak CPP=codewizard
```

or

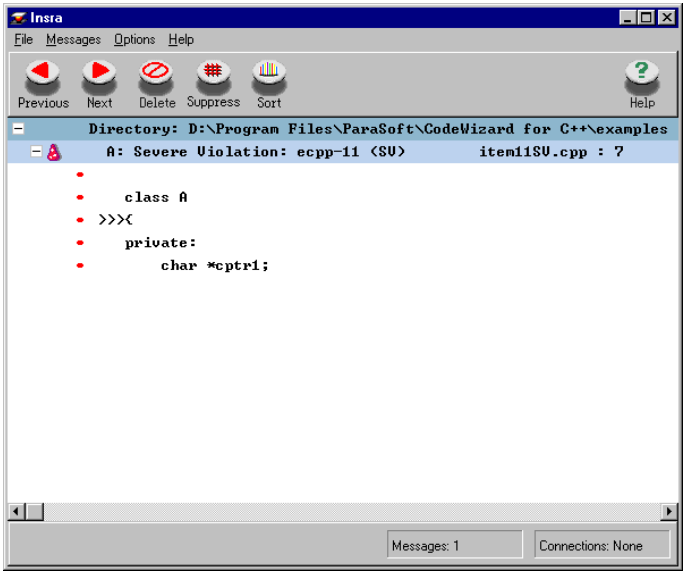
```
cwmake -f foo.mak CPP=codewizard
```

at the command prompt.

Results

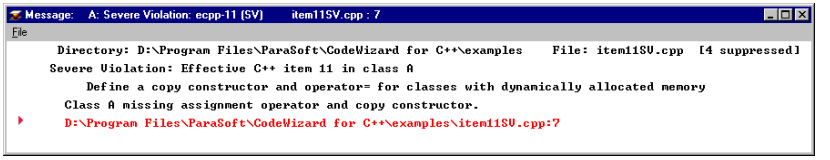
After you run CodeWizard, it will analyze the code for violations and report violation messages in Insra.

In Insra, click the “+” sign next to the message header to reveal the source code where the violation occurs.



Double-click a message header to open a Message window containing:

- The line of source code where the violation occurred.
- An explanation of the violation detected.


Message: A: Severe Violation: ecpp-11 (SV) item11SV.cpp : 7
File
Directory: D:\Program Files\ParaSoft\CodeWizard for C++\examples File: item11SV.cpp [4 suppressed]
Severe Violation: Effective C++ item 11 in class A
Define a copy constructor and operator= for classes with dynamically allocated memory
Class A missing assignment operator and copy constructor.
D:\Program Files\ParaSoft\CodeWizard for C++\examples\item11SV.cpp:7

To make immediate corrections to the source code, simply double-click the excerpt of code shown in Insra, or click the arrow in the Message window. This will open the file in your selected editor.

> **Note:** By default, CodeWizard analyzes the code, but does not pass it to the compiler. If you want CodeWizard to pass the code to the compiler, you need to clear the **Analyze Only** option in the Preferences tab of the CodeWizard Control Panel.

Preventing Errors in Embedded Development

CodeWizard now supports embedded development by:

- Enforcing a set of coding standards designed specifically to prevent errors in C/C++ embedded software development.
- Allowing you to easily create and enforce your own embedded software development coding standards.

Enforcing Embedded Development Coding Standards

Important: To use CodeWizard on your embedded projects, you must compile your code with one of CodeWizard's supported compilers prior to running it through CodeWizard. You do not need to stop using your regular compiler; rather, you should use a supported compiler before you check your code with CodeWizard, fix the problems found, then continue to compile your code with your regular compiler. Supported compilers include:

- Microsoft Visual C++
- gcc/g++ 2.9x

The embedded coding standards are not enabled by default. To configure CodeWizard to enforce these coding standards:

1. Open the CodeWizard Control panel in one of the following ways:
    - Click the **Launch CWPanel** tool bar button.
    - Choose **Tools> Launch CWPanel**.
    - Choose **Start> Programs> CodeWizard> CodeWizard Panel**.
2. In the Control Panel's Rules tab, click **Add**. A file chooser will open.

3. In the file chooser, choose the file on the path <codewizard_installation_directory>/rules/embedded.txt, then click **Open**.
4. Click **OK** or **Apply** to apply these settings.

After you have performed these initial configuration steps, CodeWizard will enforce embedded development coding standards whenever you run CodeWizard.

Creating Customized Embedded Development Coding Standards

You can also extend and customize CodeWizard's set of embedded development coding standards with the RuleWizard feature that lets you graphically create your own company, personal, or target-specific coding standards as well as modify existing coding standards. For information on RuleWizard, see "Creating Custom Coding Standards" on page 23.

Embedded Development Coding Standards

The set of coding standards designed especially for embedded software developers includes:

- ArrayElementAccess.rule
- AssignCharTooHigh.rule
- AssignCharTooLow.rule
- AssignUnCharTooHigh.rule
- AssignUnCharTooLow.rule
- BreakInForLoop.rule
- CastFuncPtrToPrimPtr.rule
- CastPointer.rule
- CastUnsigned.rule

- CharacterTest.rule
- CharCompareLeft.rule
- CharCompareRight.rule
- CommaOperator.rule
- ConstParam.rule
- ConstPointerFunctionCall.rule
- DeclareArrayMagnitude.rule
- DeclareBitfield.rule
- DeclareRegister.rule
- DeclareStaticLocal.rule
- DeclDimArray.rule
- DoWhile.rule
- EqualityFloatLeft.rule
- EqualityFloatRight.rule
- ExplicitEnumValues.rule
- ExplicitLogicalTest.rule
- FileNameConvention.rule
- ForLoopVarAssign.rule
- FractionLoss.rule
- FuncModifyGlobalVar.rule
- FunctionSize.rule
- GlobalNameHidden.rule
- GlobalPrefixExclude.rule
- GlobalVarFound.rule
- HeaderInitialization.rule
- IfAssign.rule
- IfElse.rule

- InitCharOutOfRange.rule
- InitPointerVar.rule
- InitUnCharOutOfRange.rule
- LocalVariableNames.rule
- LongConst.rule
- ManyCases.rule
- ModifyInCondition.rule
- NameBool.rule
- NameConflict.rule
- NameConstantVar.rule
- NameDataMember.rule
- NameDouble.rule
- EnumNamingConvention.rule
- NameEnumType.rule
- NameFloat.rule
- NameGlobalVar.rule
- NameInt.rule
- NameIsFunction.rule
- NameLongInt.rule
- NamePointerVar.rule
- NameShortInt.rule
- NameSignedChar.rule
- NameString.rule
- NameStructType.rule
- NameUnsignedChar.rule
- NameUnsignedInt.rule
- NameVariable.rule

- NamingStructUnionMembers.rule
- NonScalarTypedefs.rule
- NumberFunctionParam.rule
- PassByValue.rule
- PointerParamDereference.rule
- ReferenceInitialization.rule
- SourceFileSize.rule
- SourceNamingConvention.rule
- TooManyFields.rule
- UnionFieldNotDefined.rule
- UnnecessaryEqual.rule
- UnusedLocalVar.rule
- UnusedParameter.rule
- UsePositiveLogic.rule
- ImplicitUnsignedInit.rule
- BitwiseInCondition.rule
- ExprInSizeof.rule
- UnreachableCode.rule
- SingularSwitchStatement.rule

Creating Custom Coding Standards

(Version 3.x Only)

Custom coding standards are rules that are specific to a certain development team, or even a certain developer. There are two types of custom coding standards: company coding standards and personal coding standards. Company coding standards are rules that are specific to your company or development team. For example, a rule that enforces a naming convention unique to your company would be a company coding standard. Personal coding standards are rules that help you prevent your most common errors. Every time you make an error, you should determine why it occurred, then design a personal coding standard that prevents it from reoccurring. If you do this religiously, you will quickly build a set of coding standards that can prevent your most common errors from entering your code.

CodeWizard's RuleWizard feature lets you design custom coding standards by graphically expressing the pattern that you want CodeWizard to look for during automatic coding standard enforcement. Rules are created by selecting a main "node," then adding additional elements until the rule expresses the pattern that you want to check for. Rule elements are added by pointing, clicking, and entering values into dialog boxes. You can also use this tool to customize many of CodeWizard's built-in coding standards.

To launch RuleWizard, click the **RuleWizard** button in the CodeWizard Visual C++ tool bar, or choose **Start> Programs> CodeWizard> RuleWizard**.

A complete user's guide is available in RuleWizard; to access this user's guide, choose **Help> RuleWizard Documentation** in the RuleWizard GUI. Refer to the RuleWizard User's Guide for information about creating, enforcing and enabling/disabling rules.

Customizing Output With Suppressions

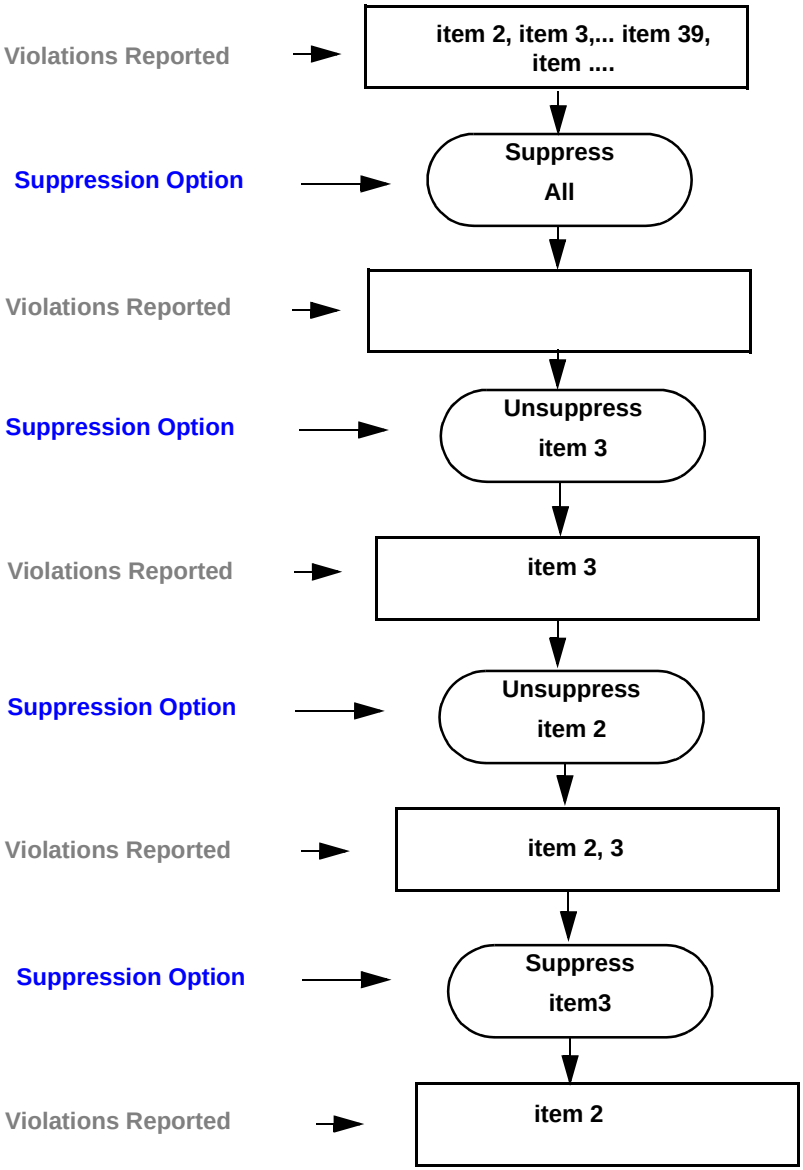
Suppressions stop CodeWizard from enforcing certain coding standards. You can use suppressions to tailor CodeWizard's output to your development team and the current project. By default, CodeWizard is configured to suppress all violations in the Universal Coding Standard category and all violations that have an Informational severity, and to unsuppress any enabled User items.

Topics discussed in this section include:

- “How Suppression Options Work”
- “Adding a Suppression Option”
- “Deleting a Suppression Option”
- “Moving a Suppression Option”
- “Determining Where Suppression Options Are Saved”
- “An Example With Suppressions”

How Suppression Options Work

Suppression options are read from top to bottom when CodeWizard determines which item violations will be reported and which will be suppressed. Because of this, you can think of a series of suppression options as a series of sieves that remove options as they pass through from top to bottom of the suppressions page. Conversely, unsuppress options can restore violations that were screened out by earlier suppress options. This can get complicated when many suppress and unsuppress options are being used concurrently, but offers a very powerful method of controlling the messages that will be displayed. The following flow chart illustrates one simple example.


Violations Reported
item 2, item 3,... item 39, item ....
Suppression Option
Suppress All
Violations Reported
Suppression Option
Unsuppress item 3
Violations Reported
item 3
Suppression Option
Unsuppress item 2
Violations Reported
item 2, 3
Suppression Option
Suppress item3
Violations Reported
item 2

Adding a Suppression Option

You can enter suppressions in the Suppressions Control Panel, which is accessible by opening the Control Panel, then clicking the **Suppressions** button in the Preferences tab.

To add a new suppression option, place your cursor in the table row where you want the suppression option inserted, then click the **Insert** button. As is, this new option will suppress all violations reported by CodeWizard.

To determine exactly what violations this option suppresses (or unsuppresses), edit its various fields. Each field can be modified to restrict the messages that will be suppressed or unsuppressed. The available fields are:

- The Action Field
- The Item Field
- The Type Field
- The Class Field
- The File Field
- The Notes Field

The Action Field

This field lets you choose between suppressing and unsuppressing an item. Clicking an entry in the **Action** field causes a pull down menu button to appear.

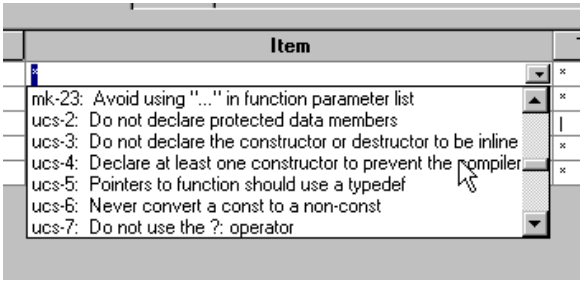
This menu contains two options:

- **Suppress:** suppress all messages indicated in the other fields.
- **Unsuppress:** unsuppress all messages indicated in the other fields.

The Item Field

The **Item** field lets you select the item violation that you would like to suppress or unsuppress. By default, there is an asterisk present, which signifies that all items are suppressed or unsuppressed (depending on which option you selected in the **Action** field).

To select the item number, click in the Item field. A pull-down menu button will appear. Click the button to display the choices available.

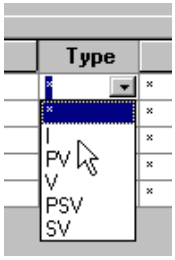

Item
mk-23: Avoid using "..." in function parameter list
ucs-2: Do not declare protected data members
ucs-3: Do not declare the constructor or destructor to be inline
ucs-4: Declare at least one constructor to prevent the compiler
ucs-5: Pointers to function should use a typedef
ucs-6: Never convert a const to a non-const
ucs-7: Do not use the ?: operator

Choose the item that you would like to suppress or unsuppress.

* matches all item numbers. The prefix "ecpp" stands for Effective C++, "mecpp" for More Effective C++, "mk" for Meyers-Klaus, and "ucs" for Universal Coding Standards; "user" is used to indicate rules created in RuleWizard or built-in rules that can be modified in RuleWizard.

The Type Field

The **Type** field allows you to select the type of violation for which messages will be suppressed or unsuppressed. To select the type, click the **Type** field. A pull-down menu button will appear.



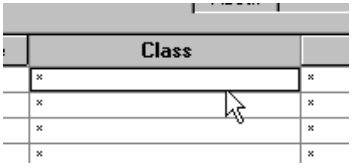
This menu contains the following options (in increasing order of seriousness):

- **I** Informational (suppressed by default)
- **PV** Possible Violation
- **V** Violation
- **PSV** Possible Severe Violation
- **SV** Severe Violation

***** Matches all types

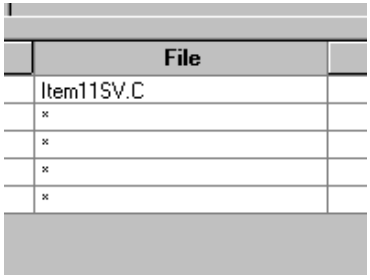
The Class Field

The **Class** field allows you to enter a class for which messages will be suppressed or unsuppressed. A field containing only "*" will match all classes To enter the class, click the **Class** field. A text field will open. Enter the desired class name in the text field, then press **Enter**.



The File Field

This field allows you to enter a file for which messages will be suppressed or unsuppressed. A field containing only "*" will match all files. To enter a file name, type it in the **File** field, or double-click the **File** field and select a file using the file chooser that opens.



The Notes Field

This field allows you to create notes to explain the purpose of the current suppression item. To enter a note, click the **Note** field. A text field will open. Enter the desired note in the text field, then press **Enter**.

Deleting a Suppression Option

To delete a suppression option, click it to select it, then click the **Delete** button.

Once this deletion has been applied, the effects of this option will be gone. This change will appear in Insra immediately.

Moving a Suppression Option

You may move individual suppression options into new locations on the suppressions page by clicking the **Move Up** and **Move Down** buttons. This will affect how CodeWizard reports item violations. For more information on this topic see “How Suppression Options Work” above.

Determining Where Suppression Options Are Saved

The area at the bottom of the suppressions page allows you to specify which file CodeWizard will use for saving suppression options.

If you are not sure where you want to put the file, the **Browse** button presents you with a dialog box with which to select the desired location and file name. Alternatively, you may type the path and file name directly into the **File** field at the bottom of the suppressions page.

Whichever method is used, CodeWizard will record any suppression options added to that file. These options are global for the current user. Different users may have different suppression option files, but each user may have only one.

An Example With Suppressions

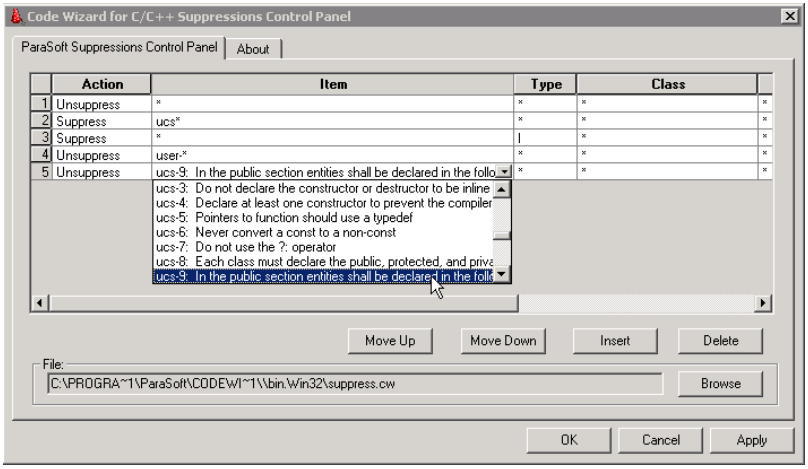
This section will build on the simple example and show how to use suppressions.

For example, let’s assume that you have just run the simple example, then have decided that you want to unsuppress all violations of rule ucs-19. This rule states that a class that has pointer members shall have an `operator=` and a copy constructor. Adhering to this rule prevents memory leaks and data corruption. If you do not define a copy construc-

tor, the default constructor will be used, which is usually *not* the desired behavior when a class has pointer members.

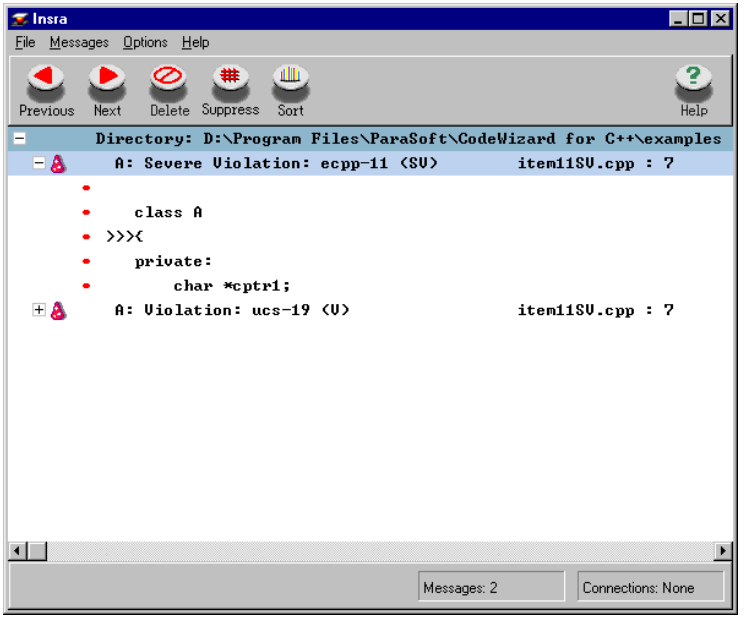
To have CodeWizard report all violations of ucs-19 that it finds in all files that it analyzes, perform the following steps:

1. To open the Suppressions Control Panel, click the **CWPanel** icon, then go to the Preferences tab and click the **Suppressions** button. The Suppressions Control Panel will open.
2. Place your cursor in the last row of suppressions, then click the **Insert** button. An additional row of asterisks will appear.
3. In the new suppression option's **Action** field, choose **Unsuppress**
4. In the new suppression's **Item** field, choose ucs-19.


Code Wizard for C/C++ Suppressions Control Panel
ParaSoft Suppressions Control Panel
About
Action
Item
Type
Class
1 Unsuppress
2 Suppress ucs*
3 Suppress
4 Unsuppress user-*
5 Unsuppress ucs-9: In the public section entities shall be declared in the follo
ucs-3: Do not declare the constructor or destructor to be inline
ucs-4: Declare at least one constructor to prevent the compiler
ucs-5: Pointers to function should use a typedef
ucs-6: Never convert a const to a non-const
ucs-7: Do not use the ?: operator
ucs-8: Each class must declare the public, protected, and priva
ucs-9: In the public section entities shall be declared in the follo
Move Up
Move Down
Insert
Delete
File:
C:\PROGRA~1\ParaSoft\CODEWI~1\\bin.Win32\suppress.cw
Browse
OK
Cancel
Apply

5. Click **Apply** to apply the new suppression configuration.

The Insra GUI will then report that a violation of the ucs-19 rule occurred in item11SV.cpp.



Customizing CodeWizard Options With the Control Panel

The CodeWizard Control Panel lets you set options for running CodeWizard on your files. You can open this panel in any of the following ways:

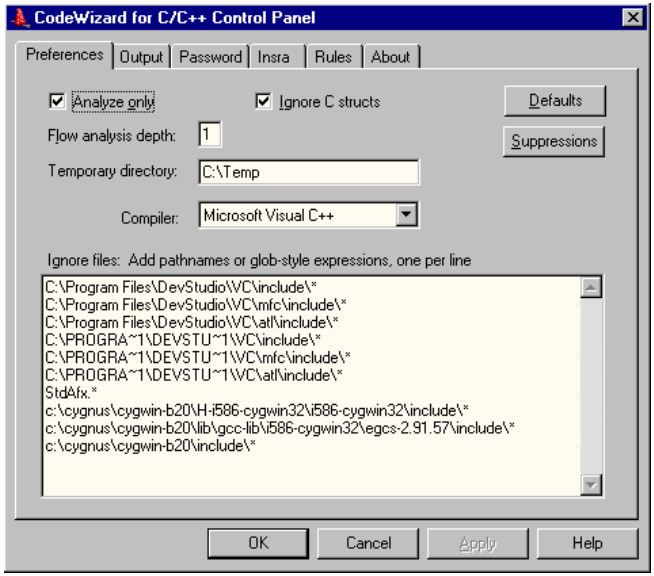
- Click the **Launch CWPanel** tool bar button in Visual C++.
- Choose **Tools> Launch CWPanel** in Visual C++.
- Choose **Start> Programs> CodeWizard> CodeWizard Panel**.

The Control Panel consists of six tabs:

- Preferences
- Output
- Password
- Insra
- Rules (Version 3.x only)
- About

Control Panel Preferences Tab

The Preferences tab lets you set the following analysis and suppression options:



- **Analyze only:** Tells CodeWizard not to pass the file being analyzed to the compiler.
- **Ignore C structs:** Tells CodeWizard to use a heuristic method for suppressing item violations in `C structs`. Turning this option off may result in some incorrect item violations, particularly in C header files.
- **Flow analysis depth:** Determines how deeply CodeWizard traverses the call stack. Currently, this option only affects item

ecpp16, which suggests that `operator=` should assign all data members. With the default setting of 1, CodeWizard will see all assignments made in `operator=` and any function called by `operator=`.

However, if one of the functions called by `operator=` calls another function which assigns a data member, CodeWizard will not see the assignment and will report a violation. With this option set to 2, CodeWizard will see the assignment and will not report a violation.

- **Ignore files:** Lets you specify which files you do not want CodeWizard to analyze. No item violations from these files will be displayed by CodeWizard.
- **Temporary directory:** Determines where CodeWizard writes its temporary files. The default is what is specified by the TEMP environment variable.
- **Compiler:** Determines what compiler CodeWizard uses. (Version 3.2 only)

Suppressions: Opens the Suppressions Control Panel (a panel that lets you enter suppression options).

Defaults: Resets all Preferences tab options to their default settings (shown in the table below).

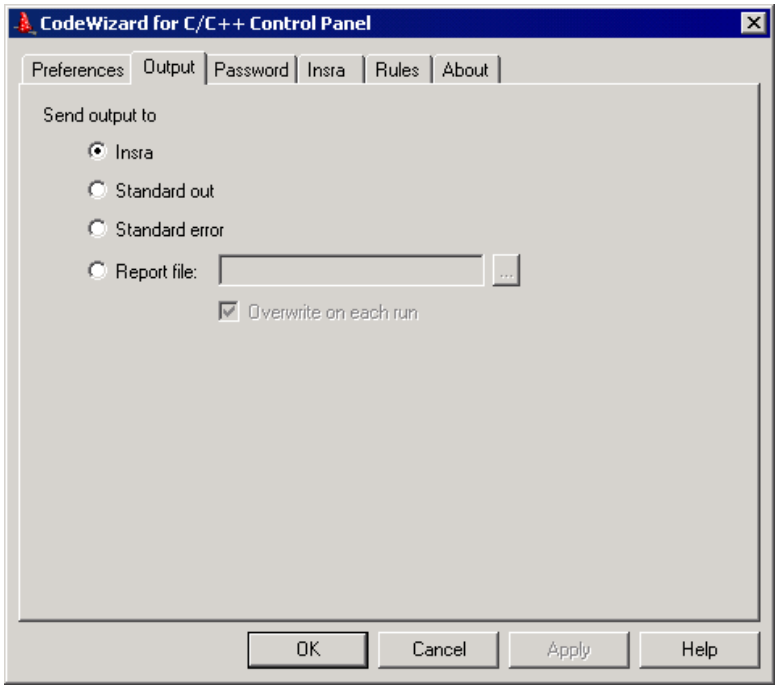
Option	Default setting
Analyze only	on
Ignore C structs	on
Flow analysis depth	1
Temporary directory	your TEMP environment variable
Compiler	Microsoft Visual C++

Ignore files

```
C:\Program Files\
DevStudio\VC\include\*

C:\Program Files\
DevStudio\VC\mfc\include\*

C:\Program Files\
DevStudio\VC\atl\include\*

C:\PROGRA~1\DEVSTU~1\VC\
include\*

C:\PROGRA~1\DEVSTU~1\VC\
mfc\include\*

C:\PROGRA~1\DEVSTU~1\VC\atl
\include\*
StdAfx.*

c:\cygnus\cygwin-b20\
H-i586-cygwin32\i586-cygwin32\
include\*

c:\cygnus\cygwin-b20\lib\
gcc-lib\i586-cygwin32\
egcs-2.91.57\include\*

c:\cygnus\cygwin-b20\include\*
```

Control Panel Output Tab

The Output tab lets you determine where CodeWizard sends its violation messages.



Available options include:

- **Insra:** Prompts CodeWizard to send output to Insra, the error-display GUI.
- **Standard out:** Prompts CodeWizard to send output to your standard output location.
- **Standard error:** Prompts CodeWizard to send output to your standard error-output location.

- **Report file:** Prompts CodeWizard to send output to the file specified in the text field. You can browse to a file by clicking the button at the end of the text field. Check **Overwrite on each run** if you want CodeWizard to overwrite the contents of your report file on every test.

Control Panel Password Tab

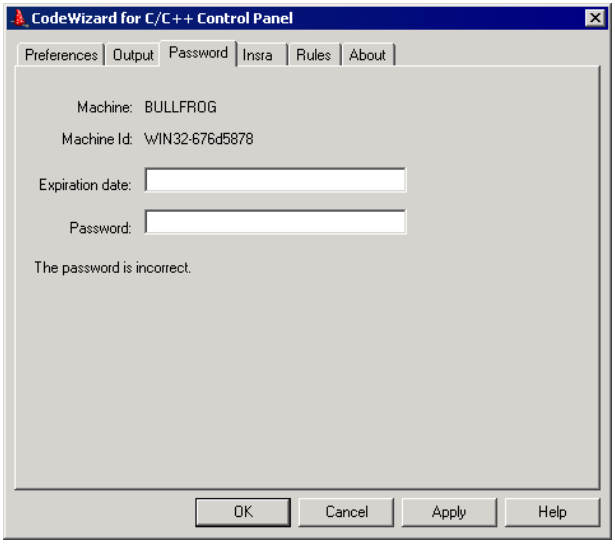
The Password tab contains your password information.

Once you install CodeWizard, you need to enter a password and expiration date before you can begin using the tool.

To receive your password and expiration date, call ParaSoft at **1-888-305-0041 x 4.**

You will need to give the **Machine** and **Machine ID** information to the representative in order to receive your password and expiration date.

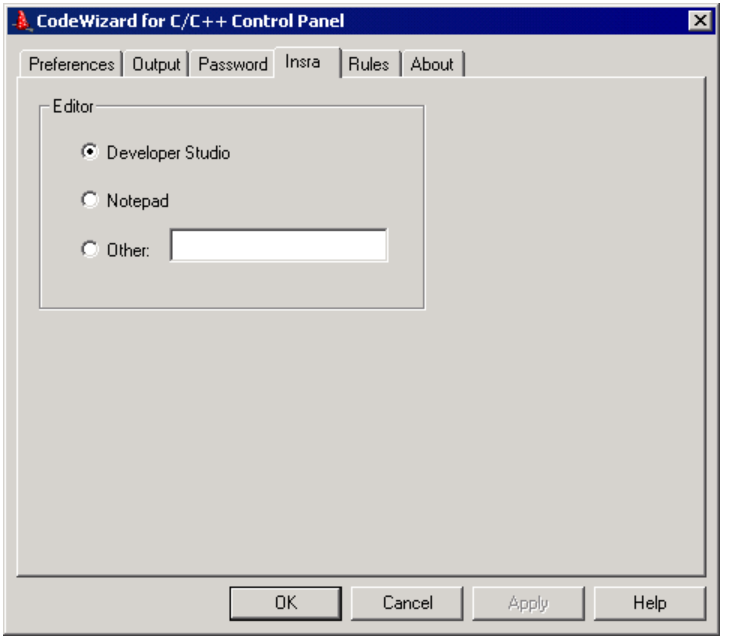
Once you receive your password and expiration date, enter them into the **Password** and **Expiration date** fields and click **OK.**



Control Panel Insra Tab

The Insra GUI lets you view and edit the source code where CodeWizard violations occur. The Insra tab lets you select the source code editor that Insra uses when displaying your source code.

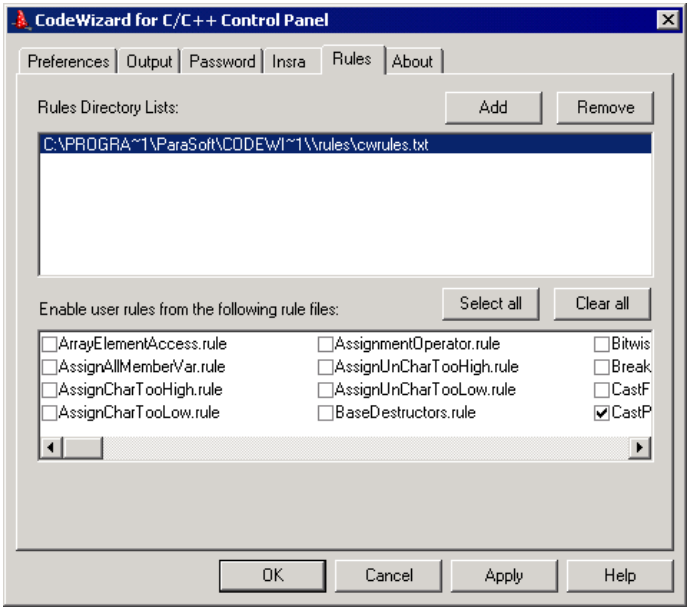
Editor options include **Developer Studio**, **Notepad**, and **Other** (enter the location of your alternative editor, as well as any arguments you want to pass to the executable, in the field provided. For example, if you wanted to use Notepad, you might enter `notepad.exe %f`).



Control Panel Rules Tab

(Version 3.x only)

The Rules tab lets you specify which custom coding standards you want to enforce.



Rules Directory List

Lets you specify which rule lists you want CodeWizard to enforce. Every directory in which you store rules should have at least one rule list (any text file); this list tells CodeWizard which of the rules in this directory it should automatically enable. To have multiple sets of rules (for example, one set for one project, one set for another project, one set for your team, one set for your company), you would create a text file for each rule set in the directory containing the rules you want the set to include.

If you want CodeWizard to enforce rules that are in a directory other than <codewizard_install_dir>/rules, and/or if you want to have a set of rules other than <codewizard_install_dir>/rules/cwrules.txt enabled by default, you need to tell CodeWizard:

- What directory contains the rules that you want to enforce.
- What file describes which rules in that directory you want enabled.

To give CodeWizard this information, create a Rules Directory list entry by clicking **Add** and specifying the path to that rules directory and rules list. CodeWizard will then automatically enable the rules listed in that rules list. Enabled rules are checked in the lower (Rules) window of this tab. If multiple text files are set to enable the same rule, the rule will be enabled only once.

If you do not want CodeWizard to enforce the rules in a certain rules list, select the appropriate Rules Directory List entry in the upper window, then click **Remove**.

Rules

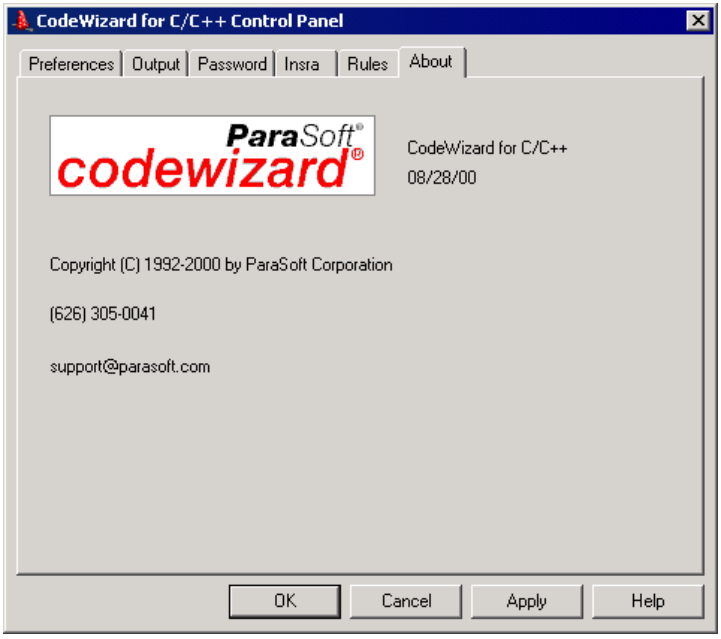
Determines which user rules are enabled. This window contains an entry for each rule contained in the directory referenced in the selected Rules Directory List entry. A check is placed by each rule that is listed in the text file referenced in the selected Rules Directory List entry; a check mark indicates that a rule is enabled.

To change which rules are enabled/disabled, check or clear the appropriate check boxes, then click **Apply**. The rule list will then be modified accordingly.

For more information on enabling and disabling rules, see the RuleWizard User’s Guide.

Control Panel About Tab

The About tab contains your CodeWizard version number as well as the telephone number of the ParaSoft Quality Consulting department.



Insra

Insra is a graphical user interface for displaying violation messages generated by CodeWizard. The messages are summarized in a convenient display, which allows you to quickly navigate through the list of violation messages, suppress messages, invoke an editor for immediate corrections to the source code, and delete messages as violations are fixed.

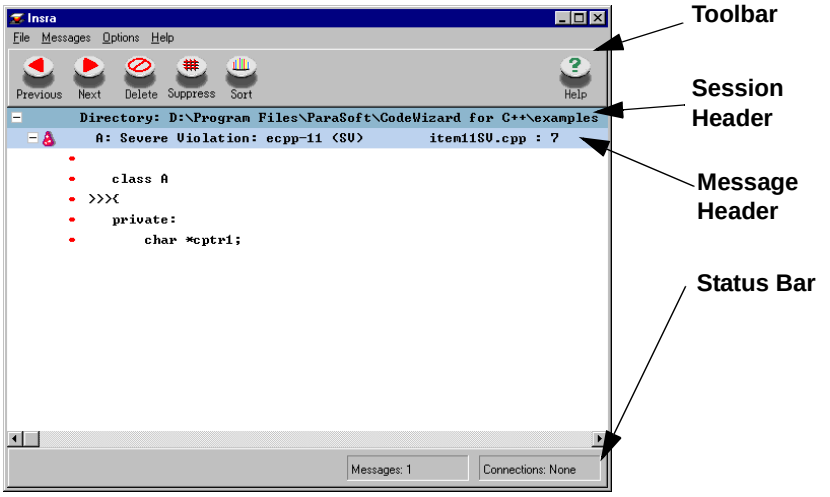
Topics discussed in this section include:

- “The Insra Display”
- “Sending Messages to Insra”
- “Viewing and Navigating”
- “Deleting Messages”
- “Suppressing Messages”
- “Miscellaneous Issues”
- “Help”
- “Troubleshooting”

The Insra Display

Status Bar

During analysis, CodeWizard makes a connection to Insra each time a violation is detected. The status bar will report the number of violation messages currently being displayed and the number of active connections. An active connection is denoted by a yellow star to the left of the session header. A connection will remain active as long as the program is still compiling/running. Insra will not allow you to delete a session header as long as its connection remains active, and you may not exit Insra until all connections have been closed.



Tool Bar

The tool bar allows you to:

- Scroll up and down through messages.
- Delete selected messages as bugs are fixed.
- Suppress violations detected by CodeWizard.
- Sort messages by order (time) reported, violation category, or directory and file.

Message Header Area

The message header area contains session headers and message headers for programs currently connected to Insra.

Session Header

When the first violation is detected for a particular compilation or execution, a session header is sent to Insra. The session header includes the following information:

- Compilation/execution
- Source file/program
- Host on which the process is running
- Process ID

Message Header

Message headers generated by CodeWizard include:

- Item violated and severity of violation
- File name
- Line number of violation

All messages sent to Insra are marked with a special icon. Please refer to the following table for a brief description of each icon.

Icon	Explanation
	CodeWizard violation message
	Trapped Signal

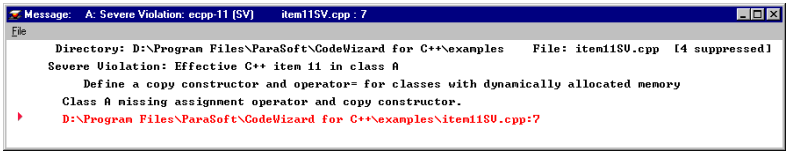
Clicking the ‘+” sign next to the message header will reveal the source code where the violation occurs. Double-clicking a message header brings up a Message window.

Error Message Window

The Message window opens when you double-click a message header. This window contains the violation message for the selected message header.

CodeWizard's Message window contains:

- The line of source code where the violation occurred.
- An explanation of the violation detected.


Message: A: Severe Violation: ecpp-11 (SV) item11SV.cpp : 7
File
Directory: D:\Program Files\ParaSoft\CodeWizard for C++\examples File: item11SV.cpp [4 suppressed]
Severe Violation: Effective C++ item 11 in class A
Define a copy constructor and operator= for classes with dynamically allocated memory
Class A missing assignment operator and copy constructor.
D:\Program Files\ParaSoft\CodeWizard for C++\examples\item11SV.cpp:7

To make immediate corrections to the source code, simply double-click the excerpt of code shown in Insra, or click the arrow in the Message window. This will open the file in a text editor

Sending Messages to Insra

By default, both CodeWizard sends output messages to Insra.

You may choose to send your output to another location, such as `stderr`, `stdout`, or a report file of your choice.

To change your output location, open the Control Panel, and choose one of the following options in the Output tab:

- **Insra:** Sends output to Insra, the error-display GUI.
- **Standard out:** Sends output to your standard output location.
- **Standard error:** Sends output to your standard error-output location.
- **Report file:** Sends output to a particular file you have created for this purpose.

When CodeWizard is configured to send output to Insra, CodeWizard attempts to establish a connection to Insra each time a violation is detected. If Insra is not yet running, it will automatically start. Once the connection is established, a session header and all corresponding message headers will be reported in the order they were detected. Each new compilation or program, with its own session header and messages, will be displayed in the order in which it connected to Insra.

Viewing and Navigating

Message headers sent to Insra are denoted by specific icon. (See “The Insra Display”). The body of the currently selected message is displayed in a separate Message window. Double-click the message header to view the message itself. The message header area and the Message window are both resizable, and scroll bars are also available to access text that is not visible.

Currently active messages become inactive when they are deleted or suppressed

Deleting Messages

Once violation messages have been read and analyzed, you may wish to clear them from the window. The **Delete** button on the Insra tool bar allows you to remove messages from the display as violations are corrected in your code. A message or an entire session may be removed by selecting the corresponding entry in the message header area and clicking the **Delete** button. A message can also be deleted by selecting **Messages> Delete** from the menu bar.

Suppressing Messages

You can use suppressions to tailor CodeWizard's output to your development team and the current project. By default, CodeWizard is configured to suppress all violations that have an Informational severity and all violations in the Universal Coding Standard category, then unsuppress any violations that have a Severe Violation severity and unsuppress any enabled User items.

Suppressions are entered in the Suppressions Control Panel, which is accessible by clicking the **Suppress** button in Insra when Insra is running and contains violations, or by clicking the **Suppressions** button in the CodeWizard Panel's Preferences tab.

For more information about suppressing and unsuppressing messages, see "Customizing Output With Suppressions".

Miscellaneous Issues

Suppression options are read from top to bottom when determining which messages will be displayed and which will not.

Viewing Source Files

You can view the corresponding source file and line number for a particular violation message by double clicking on any line of the stack trace displayed in the Message window. In most cases, the file and line number associated with a given message have been transmitted to Insra. If Insra is unable to locate the source file, a dialog box will appear requesting that you indicate the correct source file.

Selecting an Editor

In addition to the location of the source file, Insra must also know the name of your editor, and (if available) the command line syntax, in order to display the correct file and line from the original source code.

Insra determines what editor to use by reading the option in the Insra tab of the CodeWizard Control Panel. If you want to use Developer Studio or Notepad, select the appropriate button; if you want to use a different editor, select the **Other** option and enter the executable in the field to the right of that option.

Saving/Loading Messages

All current messages can be saved to a file by selecting **File> Save** or **File> Save As** from the menu bar. A dialog box allows you to select the destination directory and name of the report file. Report files have the default extension `rpt`. After a report file name has been selected, subse-

quent **File> Save** selections save all current messages into the report file without prompting for a new filename. A previously saved report file can be loaded by selecting **File> Load** from the menu bar. A dialog box then allows you to select which report file to load.

Help

Online help can be obtained by choosing **Help** from the menu bar. This will provide a list of topics on the use of Insra.

Context-sensitive help is accessible by simply clicking the **Help** button on the tool bar. When selected, the mouse cursor changes to the question mark arrow combination; clicking any visual element of Insra will open up a help window with a description of that item.

Troubleshooting

Insra Does Not Start Automatically

Symptom:

While compiling or running, your program seems to hang when output is directed to Insra and Insra is not yet running.

Solution:

Run Insra by hand. You can do this in any one of the following ways:

- Click the **Insra** icon in the *Insure++* tool bar.
- Select the **Insra** command from the Developer Studio **Tools** menu.
- Choose **Start> Programs> CodeWizard> Insra**.
- Type

  ```
  start insra
  ```

  at the prompt.

Wait for Insra to appear, and then run or compile your program again. Output should now be sent to Insra.

Source Browsing is Not Working

Symptom:

```
***Error while attempting to spawn browser
execvp failed!
```

Solution:

Insra attempted to launch your editor to view the selected source file, but could not locate either xterm or your editor on your path. Please make sure that both of these applications are in directories that are on your path or that you call them with their complete pathnames.

Items Enforced

CodeWizard reports violations of "items" described in several popular Scott Meyers books, including Effective C++ and More Effective C++, and in an article written by Martin Klaus and published in the February 1997 issue of *Dr. Dobbs' Journal.* Additional items, referred to as Universal Coding Standards, and new items reported by Meyers and Martin Klaus are also included.

Using CodeWizard's new RuleWizard feature, you can even create your own "custom" items for CodeWizard to enforce.

Each item, along with a general description, is accompanied by its category, the severity of the violation, and whether it is enabled by default.

Items reported by CodeWizard have different levels of severity. The higher the level of severity an item is assigned, the greater the chance that violating that error will result in a bug. Each level is identified by its own unique abbreviation.

The following is a table of abbreviations used in this section and by CodeWizard.

Severity	**Explanation**
I	Informational: least chance of resulting in a bug
PV	Possible Violation
V	Violation
PSV	Possible Severe Violation
SV	Severe Violation: greatest chance of resulting in a bug

CodeWizard items are labeled "ecpp-<item number>" for Effective C++ violations, "mecpp-<item number>" for More Effective C++ violations, "MK-<item number>" for Meyers-Klaus violations, "ucs-<item number>" for ucs violations, and “user-<item number> for custom coding standards created in RuleWizard, as well as built-in, modifiable coding standards.

Each item is described in depth within the appropriate section:

- Effective C++ Items
- More Effective C++ Items
- Meyers-Klaus Items
- Universal Coding Standard Items
- User Items

Effective C++ Items

Category	Item	Description	Violation	Enabled
Shifting from C to C++	2	Prefer iostream.h to stdio.h.	I	N
	3	Use new and delete instead of malloc and free.	V	Y
Memory Management	5	Use the same form in corresponding calls to new and delete.	V	Y
	6	Call delete on pointer members in destructors.	I / V	N / Y
	7	Check the return value of new.	I	N
	8	Adhere to convention when writing new.	V	Y
	9	Avoid hiding the global new.	SV	Y
	10	Write delete if you write new.	SV	Y

Constructors, Destructors, and Assignment Operators	11	Define a copy constructor and assignment operator for classes with dynamically allocated memory.	V/ SV	Y / Y
	12	Prefer initialization to assignment in constructors.	I	N
	13	List members in an initialization list in the order in which they are declared.	V	Y
	14	Make destructors virtual in base classes.	SV	Y
	15	Have operator= return a reference to this*.	SV	Y
	16	Assign to all data members in operator=.	PSV	Y
	17	Check for assignment to self in operator=.	PV	Y

Classes and Functions: Design and Declaration	19	Differentiate among member functions, global functions, and friend functions.	V	Y
	20	Avoid data members in the public interface.	V	Y
	22	Pass and return objects by reference instead of by value.	V	Y
	23	Don't try to return a reference when you must return an object.	PSV	Y
	25	Avoid overloading on a pointer and a numerical type.	V	Y

Classes and Functions: Implementation	29	Avoid returning “handles” to internal data from const member functions.	SV	Y
	30	Avoid member functions that return pointers or references to members less accessible than themselves.	V	Y
	31	Never return a reference to a local object or a dereferenced pointer initialized by new within the function.	PSV / SV	Y / Y
Inheritance and Object-Oriented	37	Never redefine an inherited nonvirtual function.	PV/V	Y / Y
	38	Never redefine an inherited default parameter value.	I / V	N / Y
	39	Avoid casts down the inheritance hierarchy.	I	N

Item ecpp_2

Prefer iostream.h to stdio.h

CodeWizard finds instances of `stdio.h` functions (such as `scanf`/`printf`) and suggests changing them to `iostream.h` functions (such as `operator>>` and `operator<<`). Errors are marked as violations of Item ecpp_02.

Reason for rule: `iostream.h` functions are type-safe and extensible.

Note: This item is suppressed by default.

Example

```
/*
 * Item 2 - Prefer iostream.h to stdio.h
 */
#include <stdio.h>

int main()
{
    printf("%s\n", "Hello World");    // ECPP item 2 viola-
tion
    return 0;
}
```

CodeWizard Output

```
[item02.C:8] Prefer iostream.h to stdio.h
Informational: Effective C++ item 2
```

Item ecpp_3

Use new and delete instead of malloc and free

CodeWizard will warn you if you use `malloc` and `free` in your code. Errors are marked as violations of Item ecpp_3.

Reason for rule: `new` and `delete` can handle constructors and destructors.

Example

```
/*
 * Item 3 - Use new and delete instead of malloc and free
 */
#include <malloc.h>
int main()
{
    char *pc;
pc = (char *)malloc(100);     // ECPP item 3 violation
    free(pc);                     // ECPP item 3 violation

    return 0;
}
```

CodeWizard Output

```
[item03.C:10] Use new instead of malloc
Violation: Effective C++ item 3

[item03.C:11] Use delete instead of free
Violation: Effective C++ Item 3
```

Item ecpp_5

Use the same form in corresponding calls to new and delete

CodeWizard checks calls to `new` and `delete` to make sure that they use the same form; it will report a violation if you call `new` but forget to use `[ ]` when calling `delete`. Errors are marked as violations of Item ecpp_5.

Reason for rule: If you do not use the same form in corresponding calls to `new` and `delete`, an incorrect number of destructors may be called.

Example

```
/*
 * Item 5 - Use the same form in corresponding
* calls to new and delete
 */
class A
{
public:
    A() {}
};

int main()
{
    A *a = new A[100];

    delete a;             // ECPP item 5 violation
}
```

CodeWizard Output

```
[item05.C:15] Use the same form in corresponding
```

```
calls to new and delete
Violation: Effective C++ item 5
Found new[] with delete.
```

Item ecpp_6

Call delete on pointer members in destructors

CodeWizard warns you if it finds a pointer member that has no corresponding `delete` in the destructor. Errors are marked as violations of Item ecpp_6.

Reason for rule: Calling `delete` on pointer members in destructors prevents memory leaks now and as the code evolves in the future.

CodeWizard will report this item as either an Informational (I) or Violation (V) violation.

Example

```
/*
 * Item 6 - Call delete on pointer members in destructors.
(SV,V)
 */
class A
{
public:
    A() {
       cptr1=new char;
       cptr2=new char;
    }
    ~A() {                  // ECPP item 6 violation
        delete cptr1;
        delete vptr1;
    }

private:
    char *cptr1;
```

```
    void *vptr1;
    char *cptr2;
};

int main()
{
    return 0;
}
```

CodeWizard Output

```
[item06.C:5] Call delete on pointer members in
destructors
Violation: Effective C++ item 6
Class A contains pointer members not obviously
deleted in destructor:
cptr2 ** allocated in constructor **
```

Item ecpp_7

Check the return value of new

CodeWizard will warn you if you do not check the return value of new. Errors are marked as violations of Item ecpp_7.

Reason for rule: In cases where new can't allocate the requested memory, it will return 0.

Note: This item is suppressed by default.

Example

```
/*
 * Item 7 - Check the return value of new
 */

int main()
{
    char *pc;

    pc = new char[10*10*10];        // ECPP item 7 violation
    pc[0] = 'x';
    delete [] pc;
    return 0;
}
```

CodeWizard Output

```
[item07.C:9] Check the return value of new
Informational: Effective C++ item 7
```

Item ecpp_8

Adhere to convention when writing new

When you write operator new, CodeWizard checks to make sure that you are being consistent with the default new. Errors are marked as violations of Item ecpp_8.

Reason for rule: If you do not adhere to convention when you write new, you may cause confusing inconsistencies for users of your new and delete operators.

Example

```
/*
 * Item 8 - Adhere to convention when writing new
 */
#include <stdlib.h>

class A
{
public:
    A() {}
    int* operator new(size_t size) // ECPP item 8 violation
        return (int *)(new int);
     };
};

int main()
{
    return 0;
}
```

CodeWizard Output

```
[item08.C:10] New should return void *
Violation: Effective C++ item 8
```

Item ecpp_9

Avoid hiding the global new

CodeWizard can detect when the global new is hidden by an operator new. Errors are marked as violations of Item ecpp_9.

Reason for rule: If you hide the global new, normal new operator functionality will be unavailable to maintainers of your code.

Example

```
/*
 * Item 9 - Avoid hiding the global new
 */
#include <stdlib.h>
void ErrorHandler() {};
class A
{
public:
    void* operator new(size_t size, void (*pehf)())  // ECPP
item 9 violation
    {
        return new int[size];
    }

    void operator delete(void *A)
    {
        delete A;
    }
};
int main()
{
    A *a = new (ErrorHandler) A;
```

```
    return 0;
}
```

CodeWizard Output

```
[item09.C:12] Avoid hiding the global new
Severe violation: Effective C++ item 9
```

Item ecpp_10

Write delete if you write new

CodeWizard makes sure that if you write your own version of `operator new`, you also write a corresponding `operator delete`. Errors are marked as violations of Item ecpp_10.

Reason for rule: If you write `delete` when you write `new`, you'll ensure that `new` and `delete` share the same assumptions.

Note: Item user_212 is a customizable version of this rule.

Example

```
/*
 * Item 10 - Write delete if you write new.
 */

#include <stdlib.h>
class A
{                 // ECPP item 10 violation
public:
    A() {}
    void* operator new(size_t size)
    {
        return new int[size];
    }
};
int main()
{
    A *a = new A;

    return 0;
}
```

CodeWizard Output

```
[item10.C:11] Write delete if you write new
Severe violation: Effective C++ item 10
```

Item ecpp_11

Define a copy constructor and assignment operator for classes with dynamically allocated memory

CodeWizard will make sure copy constructors and assignment operators have been defined in classes with dynamically allocated memory. Errors are marked as violations of Item ecpp_11.

Reason for rule: By defining a copy constructor and assignment operator, you will achieve significant memory savings and increased speed.

Example

CodeWizard will report violations of Item 11 as either Violation (V) or Severe (SV). Examples of both are provided here.

```
/*
 * Item 11 - Define a copy constructor and an assignment
operator for classes
 *           with dynamically allocated memory. (V)
 */

class A
{
public:
    class X {}
    A() {                           // ECPP item 11 violation
        cptr1 = new char[100];
        if (!cptr1) {
            throw X();
        }
```

```
    }
    ~A() {}

private:
    char *cptr1;
    void *vptr1;
    char *cptr2;
};

int main()
{
    return 0;
}



/*
 * Item 11 - Define a copy constructor and an assignment
operator for classes
 *           with dynamically allocated memory. (SV)
 */

class A
{
private:
    char *cptr1;
    void *vptr1;
    char *cptr2;

public:
    A() {}
    ~A() {                      // ECPP item 11 violation
        delete cptr1;
        delete vptr1;
        delete cptr2;
```

```
    }
};

int main()
{
    return 0;
}
```

CodeWizard Output

```
[item11V.C:7] Define a copy constructor and operator=
for classes with dynamically allocated memory
Violation: Effective C++ item 11
Class A missing assignment operator and copy
constructor.

[item11SV.C:7] Define a copy constructor and operator=
for classes with dynamically allocated memory
Severe violation: Effective C++ item 11
Class A missing assignment operator and copy
constructor.
```

Item ecpp_12

Prefer initialization to assignment in constructors

CodeWizard checks constructors to see if you are assigning data members when you should be initializing them. `const` and `reference` can only be initialized, never assigned. Errors are marked as violations of Item ecpp_12.

Reason for rule: If you use initialization instead of assignment, you will increase efficiency and call fewer member functions.

Exception: The only time you should use assignment instead of initialization for data members in a class is when you have a large number of data members of built-in types and you want them all to be initialized in the same way in each constructor.

Note: This item is suppressed by default.

Example

```
/*
 * Item 12 - Prefer initialization to assignment in construc-
tors
 */

class A
{
public:
    A(int i, float j) {           // ECPP item 12 violation
        _idata = i;
        _fdata = j;
    }

private:
```

```
    int _idata;
    float _fdata;
};

int main()
{
    return 0;
}
```

CodeWizard Output

```
[item12.C:9] Prefer initialization to assignment
in constructors
Informational: Effective C++ item 12

[item12.C:10] Prefer initialization to assignment
in constructors
Informational: Effective C++ item 12
```

Item ecpp_13

List members in an initialization list in the order in which they are declared

CodeWizard checks initialization lists to make sure that members are listed in the same order there as they were when declared in the class. Errors are marked as violations of Item ecpp_13.

Reason for rule: Class members are initialized in the order of their declaration in the class, not by the order in which they are listed in a member initialization list.

Example

```
/*
 * Item 13 - List members in an initialization list in the
 *           order in which they are declared
 */

class A
{
public:
                     // ECPP item 13 violation
    A(int i1, int i2, int i3) : idata3(i3), idata2(i2),
idata1(i1) {}

private:
    int idata1, idata2, idata3;
};

int main()
{
    return 0;
```

```
}
```

CodeWizard Output

```
[item13.C:10] List members in an initialization list
in the order in which they are declared
Violation: Effective C++ item 13
```

Item ecpp_14

Make destructors virtual in base classes

CodeWizard will verify that destructors in base classes are virtual. Errors are marked as violations of Item ecpp_14.

Reason for rule: Declaring the destructor virtual tells the compiler that it must examine the object being deleted to see where to start calling destructors.

Example

```
/*
 * Item 14 - Make destructors virtual in base classes
 */

class Base
{
public:
    Base() {}
    ~Base() {}                    // ECPP item 14 violation
};

class Derived: public Base
{
public:
     Derived() {};
    ~Derived() {};
};

int main()
```

```
{
    return 0;
}
```

CodeWizard Output

```
[item14.C:6] Make destructors virtual in base classes
Severe violation: Effective C++ item 14
Class Base is a base class but does not have a virtual
destructor
```

Item ecpp_15

Have operator= return a reference to *this

CodeWizard makes sure your assignment operators return a reference to their left-hand argument, `*this`. Errors are marked as violations of Item ecpp_15.

Reason for rule: Having `operator=` return a reference to `*this` protects you from not knowing where the temporary gets destroyed and allows you to declare the `operator=`'s parameter as a reference to `const`, which is safer than just declaring it to be a reference.

Example

```
/*
 * Item 15 - Have operator= return a reference to *this
 */

class A
{
public:
    explicit A(int i = 0) : _i(i) {}
    void operator=(const A& a) // ECPP item 15 violation
    {
        if (&a == this) {
            return;
        }

        int _i = a._i;
        return;
    }
```

```
private:
    int _i;
};

int main()
{
    return 0;
}
```

CodeWizard Output

```
[item15.C:9] Have operator= return a reference to
*this
Severe violation: Effective C++ item 15
```

Item ecpp_16

Assign to all data members in operator=

If you write `operator=`, CodeWizard makes sure you assigned to every data member of your object. Errors are marked as violations of Item ecpp_16.

Reason for rule: Assigning to all data members in `operator=` allows you to take control of your assignments.

Example

```
/*
 * Item 16 - Assign to all data members in operator=
 */

class A
{
public:
    A() {}
    A& operator=(const A&);

private:
    int _x, _y, _z;
};

A& A::operator=(const A& a) // ECPP item 16 violation
{
    if (&a == this) {
        return *this;
    }
```

```
    _x = a._x;
    _y = a._y;

    return *this;
}

int main()
{
    return 0;
}
```

CodeWizard Output

```
[item16.C:16] Assign to all data members in operator=
Possible severe violation: Effective C++ item 16
Members not assigned:
_z
```

Item ecpp_17

Check for assignment to self in operator=

CodeWizard checks your code for aliasing in assignment operators. Errors are marked as violations of Item ecpp_17.

Reason for rule: Not checking for assignment to self in `operator=` can free resources that might be needed during the process of allocating new resources. Checking for assignment to self may also save you a lot of work that you would otherwise have to do to implement assignments.

Example

```
/*
 * Item 17 - Check for assignment to self in operator=
 */

class A{
public:
    A() {}
    A& operator=(A& a)              // ECPP item 17 violation
    {
        _i = a._i;
        return *this;
    }

private:
    int _i;
};

int main()
{
```

```
    return 0;
}
```

CodeWizard Output

```
[item17.C:8] Check for assignment to self in operator=
Possible violation: Effective C++ item 17
expected: if (&a == this) return *this;
```

Item ecpp_19

Differentiate among member functions, global functions, and friend functions

CodeWizard checks declared functions to make sure they are proper for the class type used. Disallowed functions are marked as violations of Item ecpp_19.

Reason for rule: Differentiating among functions leads to more object-oriented code with behavior that is more intuitive to use and maintain.

Example

```
/*
 * Item 19 - Differentiate among member, global, and friend
functions.
 */

class Rational
{
public:
    Rational(int _num = 0, int _den = 1);
    int numerator() const { return _num; }
    int denominator() const { return _den; }

    Rational operator*(const Rational& rhs) const;   // ECPP
item 19 violation

private:
    int _num;
    int _den;
```

```
};

Rational Rational::operator*(const Rational& rhs) const
{
    Rational temp(_num * rhs.numerator(),
                  _den * rhs.denominator());

    return temp;
}

int main()
{
    return 0;
}
```

CodeWizard Output

```
[item19.C:12] Differentiate among member functions,
global functions and friend functions
Violation: Effective C++ item 19
Function * should be global
```

Item ecpp_20

Avoid data members in the public interface

CodeWizard warns you if data members are present in the public interface. Instead of making data members public, you should use functions. Errors are marked as violations of Item ecpp_20.

Reason for rule: Avoiding data members in the public interface provides more precise control over accessibility of data members, reduces confusion for callers, and enables functional abstraction (allowing the replacement of data members with computations without impacting users of the class). It also improves consistency, flexibility, and access-control.

Example

```
/*
 * Item 20 - Avoid data members in the public interface
 */

class A
{
public:
    int _idata2;           // ECPP item 20 violation

    int ReadData1(void) { return _idata1; }

    void WriteData1(int ival) { _idata1 = ival; }

private:
    int _idata1;
};
```

```
int main()
{
    return 0;
}
```

CodeWizard Output

```
[item20.C:6] Avoid data members in the public
interface
Violation: Effective C++ item 20
Public data members for class A:
_idata2
```

Item ecpp_22

Pass and return objects by reference instead of by value

CodeWizard can detect where an object has been passed by value instead of by reference. Code Wizard marks these errors as violations of Item ecpp_22.

Reason for rule: Passing and returning objects by reference is more efficient than passing by value because no new objects are being created and because it avoids the "slicing problem."

Exception: There are situations in which you can't pass an object by reference (see Item ecpp_23). There also may be a situation where the object is so small that it would be more efficient to pass by value instead of by reference.

Example

```
/*
 * Item 22 - Pass and return objects by reference instead
 *           of by value
 */

class A
{
public:
    A() {}
    A foo(const A a)      // 2 ECPP item 22 violations
    {                     //     passing variables into foo
by value
        return a;         //     returning by value when it
is not required
    }
```

```
};

int main()
{
    return 0;
}
```

CodeWizard Output

```
[item22.C:10] Pass objects by reference instead of
by value
Violation: Effective C++ item 22
Parameter a of function foo passed by value

[item22.C:10] Return objects by reference instead of by
value
Violation: Effective C++ item 22
Function foo returns object by value
```

Item ecpp_23

Don't try to return a reference when you must return an object

CodeWizard can detect when you return a reference where you are supposed to return an object. Errors are marked as violations of Item ecpp_23.

Reason for rule: Returning a reference instead of an object will result in corrupt data or a memory leak.

Example

```
/*
 * Item 23 - Don't try to return a reference when you must
return an object.
 */

class A
{
public:
    A(int num = 0, int den = 1) : _num(num), _den(den) {}
    int numerator() const { return _num; }
    int denominator() const { return _den; }

private:
    int _num;
    int _den;
};

// ECPP item 23 violation
A& operator*(const A& lhs, const A& rhs)
```

```
{
    A temp(lhs.numerator() * rhs.numerator(),
                  lhs.denominator() * rhs.denominator());
    return temp;
}

int main()
{
    return 0;
}
```

CodeWizard Output

```
[item23.C:19] Don't try to return a reference when you
must return an object
Possible severe violation: Effective C++ item 23
Operator * should return an object
```

Item ecpp_25

Avoid overloading on a pointer and a numerical type

CodeWizard can detect when you are overloading on a pointer and a numerical type. Errors are marked as violations of Item ecpp_25.

Reason for rule: Calling with an argument of zero will invoke the numerical type even though it is intuitively ambiguous.

Example

```
/*
 * Item 25 - Avoid overloading on a pointer and a numerical
type.
 */

class A
{
public:
    int func(char *ch)
    {
       char c=*ch;
       return 0;
    }
    int func(int i)           // ECPP item 25 violation
    {
        int var=i;
        return 0;
    }
};

int main()
```

```
{
    return 0;
}
```

CodeWizard Output

```
[item25.C:8] Avoid overloading on a pointer and a
numerical type
Violation: Effective C++ item 25
Function func overloaded at:
[item25.C:8]
[item25.C:13]
```

Item ecpp_29

Avoid returning "handles" to internal data from const member functions

CodeWizard can detect when `const` member functions return “handles” to information that should be hidden. Errors are marked as violations of Item ecpp_29.

Reason for rule: If you return “handles” to internal data, you will allow calling functions to modify variables that they shouldn't have access to.

Example

```
/*
 * Item 29 - Avoid returning "handles" to internal data from
 *            const member functions
 */

class A
{
public:
    A()
    {
        ptr = 0;
    }
    operator char*() const { return ptr; }     // ECPP item
29 violation

private:
    char *ptr;
};

int main()
```

```
{
      return 0;
}
```

CodeWizard Output

```
[item29.C:13] Avoid returning "handles" to internal
data from const member functions
Severe violation: Effective C++ item 29
```

Item ecpp_30

Avoid member functions that return pointers or references to members less accessible than themselves

CodeWizard can detect when you write member functions that give clients access to restricted members. Errors are marked as violations of Item ecpp_30.

Reason for rule: Members are made private or protected to restrict access to them, so it doesn't make sense to write functions that give random clients the ability to freely access restricted members.

Exception: Cases where performance constraints dictate that you write a member function that returns a reference or pointer to a less-accessible member. To avoid sacrificing private and protected access restrictions, return a pointer to or a reference to a `const` object (see Item ecpp_ 21).

Example

```
/*
 * Item 30 - Avoid member functions that return pointers or
 *           references to members less accessible than them-
selves
 */


class A
{
public:
    int& GetA() { return _personalA; };       // ECPP item 30
violation


protected:
    int _personalA;
```

```
};

int main()
{
    return 0;
}
```

CodeWizard Output

```
[item30.C:9] Avoid member functions that return
pointers or references to members less accessible
than themselves
Violation: Effective C++ item 30
```

Item ecpp_31

Never return a reference to a local object or a dereferenced pointer initialized by new within the function

CodeWizard can detect when you return a reference to a local object or dereferenced pointer. Errors are marked as violations of Item ecpp_31.

Reason for rule: Returning a reference to a local object or a dereferenced pointer initialized by new within the function may cause a memory leak.

Example

CodeWizard will report violations of Item 31 as either Potentially Severe Violations (PSV) or Severe Violations (SV). Examples of both are provided here.

```
/*
 * Item 31 - Never return a reference to a local object or a
 *           dereferenced pointer initialized by new within
 *           the function
 */

class A
{
public:
    A(int xval, int yval) : _x(xval), _y(yval) {}

    friend A& operator+(const A& p1, const A& p2);

private:
    int _x, _y;
```

```
};

A& operator+(const A& p1, const A& p2)         // ECPP item
31 violation
{
    A *result = new A(p1._x + p2._x, p1._y + p2._y);

    return *result;
}

int main()
{
    return 0;
}



/*
 * Item 31 - Never return a reference to a local object or a
 *           dereferenced pointer initialized by new within
 *           the function
 */

class A
{
public:
    A(int xval, int yval) : _x(xval), _y(yval) {}

    friend A& operator+(const A& p1, const A& p2);

private:
    int _x, _y;
};
```

```
A& operator+(const A& p1, const A& p2)      // ECPP item 31
violation
{
    A result(p1._x + p2._x, p1._y + p2._y);

    return result;
}

int main()
{
    return 0;
}
```

CodeWizard Output

```
[item31PS.C:22] Never return a dereferenced local
pointer initialized by new in this function scope
Possible severe violation: Effective C++ item 31
Dereferenced local pointer result returned.

[item31SV.C:22] Never return a reference to a local
object
Severe violation: Effective C++ item 31
Reference to object result returned.
```

Item ecpp_37

Never redefine an inherited nonvirtual function

CodeWizard can detect when you redefine an inherited nonvirtual function. These errors are violations of Item ecpp_37.

Reason for rule: Redefining an inherited nonvirtual function may cause objects to behave incorrectly.

Example

CodeWizard will report Item 37 errors as either a Possible Violation (PV) or a Violation (V). Examples of both are provided here.

```
/*
 * Item 37 - Never redefine an inherited nonvirtual function
 */

template<class T>
class Base
{
public:
    void foo(T tval);
};

template<class T>
class Derived: public Base<T>
{
public:
    void foo(int tval);           // ECPP item 37 violation
};
```

```
int main()
{
    return 0;
}



/*
 * Item 37 - Never redefine an inherited nonvirtual function
 */

class Base
{
public:
    void func(void) {};
};

class Derived: public Base
{
public:
    void func(void) {};    // ECPP item 37 violation
};

int main()
{
    return 0;
}
```

CodeWizard Output

```
[item37PV.C:16] Never redefine an inherited nonvirtual
function
Possible violation: Effective C++ item 37
Redefinition of function foo in class Derived
```

```
Function foo is inherited from class Base

[item37V.C:14] Never redefine an inherited nonvirtual
function
Violation: Effective C++ item 37
Redefinition of function func in class Derived
Function func is inherited from class Base
```

Item ecpp_38

Never redefine an inherited default parameter value

CodeWizard can detect where you redefine an inherited virtual function with a default parameter value. Errors are marked as violations of Item ecpp_38.

Reason for rule: As illustrated in the first example below, inherited nonvirtual functions should never be redefined. As illustrated in the second example below, virtual functions are dynamically bound and default parameter values are statically bound.

Example

CodeWizard will report Item 38 errors as either Informational (I) or as a Violation (V). Examples of both are provided here.

```
/*
 * Item 38 - Never redefine an inherited default parameter
value
 */

template<class T>
class Base
{
public:
    virtual void func(T i = -1111) {}
};

template<class T>
class Derived: public Base<T>
{
public:
```

```
    virtual void func(int i = 11) {}// EECP item 38 violation
};

int main()
{
    return 0;
}


/*
 * Item 38 - Never redefine an inherited default parameter
value
 */

class Base
{
public:
    virtual int func(int i = -1111) { return i; }
};

class Derived: public Base
{
public:
    virtual int func(int i = 11) { return i;  }    // ECPP
item 38 violation
};


int main()
{
    return 0;
}
```

CodeWizard Output

```
[item38I.C:16] Never redefine an inherited default
parameter value
Informational: Effective C++ item 38
Function func in class Derived redefines default
parameter i

[item38V.C:14] Never redefine an inherited default
parameter value
Violation: Effective C++ item 38
Function func in class Derived redefines default
parameter i
```

Item ecpp_39

Avoid casts down the inheritance hierarchy

CodeWizard can detect casts from a base class pointer to a subclass pointer. Errors are marked as violations of Item ecpp_39.

Reason for rule: Allowing casts down the inheritance hierarchy leads to maintenance problems, and downcasting from a base class is always illegal.

Note: This item is suppressed by default.

Example

```
/*
 * Item 39 - Avoid casts down the inheritance hierarchy
 */

class Base {};

class Derived: public Base {};

int main()
{
    Base *pb;
    Derived *pd = (Derived *)pb; // ECPP item 39 violation

    return 0;
}
```

CodeWizard Output

```
[item39.C:12] Avoid casts down the inheritance
```

```
hierarchy
Informational: Effective C++ item 39
Class Derived inherits from class Base
```

Item ecpp_39

More Effective C++ Items

Category	Item	Description	Violation	Enabled
Basics	2	Prefer C++-style casts.	V	Y
Operators	5	Be wary of user-defined conversion functions.	I / V	N / Y
	6	Distinguish between prefix and postfix forms of increment and decrement operators.	V	Y
	7	Never overload &&, ||, or ,.	V	Y
Efficiency	22	Consider using op= instead of stand-alone op.	V	Y
	24	Understand the costs of virtual functions, multiple inheritance, virtual base classes, and RTTI.	V	Y
Techniques	26	Limiting the number of objects of a class.	I	N

Item mecpp_02

Prefer C++ style casts

CodeWizard can detect C-style casts in your code. Errors are marked as violations of Item mecpp_02.

Reason for rule: C++ casts are more specific than C casts and are much easier to locate and read.

Example

```
//
// More Effective C++ Item 2
//

class Base
{
public:
    Base();
    virtual ~Base();
};

class Derived : public Base
{
public:
    Derived();
    ~Derived();
};

int main()
{
    Base *pB;
```

```
    Derived *pD = (Derived *) pB; // MECPP item 2 violation.
    return 0;
}
```

CodeWizard Output

```
[ME-item02.C:23] Prefer C++-style casts
Violation: More Effective C++ item 2
```

Item mecpp_05

Be wary of user-defined conversion functions

CodeWizard warns you when it finds user-defined conversion functions. Errors are marked as violations of Item mecpp_ 05.

Reason for rule: Using user-defined conversion functions may result in incorrect program behavior.

Example

CodeWizard will report violations of Item 5 as either Information (I) or Violation (V). Examples of both are provided here.

```
//
// More Effective C++ Item 5
//

class A
{
public:
    A(int i): _i(i) {}       // MECPP item 5 violation
    virtual ~A() {}

    operator int() const     // MECPP item 5 violation
    {
        return _i;
    }

private:
    int _i;
```

```
};

int main()
{
    int j = 10;

    A a(12);

    if (a < j) {             // MECPP item 5 violation
        exit(1);
    }
    return 0;
}
```

CodeWizard Output

```
[ME-item05.C:8] Be wary of user-defined conversion
functions
Informational: More Effective C++ item 5
Constructor allowing conversion should be made
explicit

[ME-item05.C:11] Be wary of user-defined conversion
functions
Violation: More Effective C++ item 5
User-defined conversion should be made explicit

[ME-item05.C:26] Be wary of user-defined conversion
functions
Violation: More Effective C++ item 5
Use of implicit cast should be made explicit
```

Item mecpp_06

Distinguish between prefix and postfix forms of increment and decrement operators

CodeWizard warns you if you do not distinguish between prefix and postfix forms of increment and decrement operators. Failure to do so in ++ and -- operators results in a violation of Item mecpp_06.

Reason for rule: Prefix and postfix forms return different types (prefix forms return a reference and postfix forms return a const object). Postfix operators should be implemented in terms of the prefix operator.

Example

```
//
// More Effective C++ Item 6
//

class A
{
    friend bool operator==(const A&, int);

public:
    explicit A(int i = 0): _i(i) {}
    ~A() {}

    A& operator=(const A& a)
    {
        if (&a == this) {
            return *this;
        }
```

```
        _i = a._i;
        return *this;
    }
    A& operator=(int i)
    {
        _i = i;
        return *this;
    }
    A& operator++()
    {
        ++_i;
        return *this;
    }
    const A operator++(int)
    {
        A temp = *this;
        ++_i;
        return temp;
    }

private:
    int _i;
};

bool operator==(const A& a, int i)
{
    return (a._i == i);
}

bool operator!=(const A& a, int i)
{
    return (!(a == i));
```

```
}

int main()
{
    A a;

    for (a = 0; a != 10; a++) { // MECPP item 6 violation
        // Do something
    }

    return 0;
}
```

CodeWizard Output

```
[ME-item06.C:57] Distinguish between prefix and
postfix forms of increment and decrement
Violation: More Effective C++ item 6
Prefix form is recommended here
```

Item mecpp_07

Never overload &&, | |, or ,

CodeWizard can detect when you overload `operator && , ||` or `,`. Errors are marked as violations of item mecpp_07.

Reason for rule: Overloading these operators changes the way the compiler reads the semantics of an expression, resulting in unpredictable program behavior.

Example

```
//
// More Effective C++ Item 7
//

class A
{
public:
    A(int i) : _i(i) {}
    ~A();

    int value() { return _i; }

private:
    int _i;
};

operator&&(A& lhs, A& rhs) { // MECPP item 7 violation
    return lhs.value() && rhs.value();
}

int main()
```

```
{
    return 0;
}
```

CodeWizard Output

```
[ME-item07.C:17] Never overload &&, || or ,
Violation: More Effective C++ item 7
Function && is overloaded
```

Item mecpp_22

Consider using op= instead of stand-alone op

CodeWizard warns you whenever it finds stand-alone versions of `operator`. Errors are marked as violations of Item mecpp_22.

Reason for rule: Assignment versions of operator are more efficient than stand-alone versions.

Example

```
//
// More Effective C++ Item 22
//

class A
{
public:
    A(int i) : _i(i) {}
    ~A();

    int value() { return _i; }

    A operator+() {}       // MECPP item 22 violation

private:
    int _i;
};

int main()
{
```

```
    return 0;
}
```

CodeWizard Output

```
[ME-item22.C:13] Consider using op= instead of
stand-alone op
Violation: More Effective C++ item 22
Operator + found, but no appropriate operator += found
```

Item mecpp_24

Understand the costs of virtual functions, multiple inheritance, virtual base classes, and RTTI

CodeWizard warns you when virtual functions, multiple-inheritance, virtual base classes, and RTTI will be implemented inefficiently. Errors are marked as violations of Item mecpp_ 24.

Reason for rule: Inefficient implementation may have noticeable effects on the size of objects and the speed at which member functions execute; this may significantly impact performance.

Example

```
//
// More Effective C++ Item 24
//

class A
{
public:
    A(int i) : _i(i) {}
    virtual ~A() {}             // MECPP item 24 violation

    int value() { return _i; }

private:
    int _i;
};

int main()
```

```
{
    return 0;
}
```

CodeWizard Output

```
[ME-item24.C:9] Understand the costs of virtual
functions ...
Violation: More Effective C++ item 24
Function ~A is both virtual and inline
```

Item mecpp_26

Limiting the number of objects in a class

CodeWizard can detect when you need to limit the number of objects in a class. Errors are marked as violations of Item mecpp_ 26.

Reason for rule: Limiting the number of objects in a class can reduce code complexity.

Note: This item is suppressed by default.

Example

```
//
// More Effective C++ Item 26
//

class Base
{
public:
    class X {};
    Base()
    {
        if(numObjects >= 1)
            throw X();

        // constructor stuff here

        ++numObjects;
    }

    ~Base()
```

```
    {
        --numObjects;

        // destructor stuff here
    }

private:
    static int numObjects;
};

int main()
{
    return 0;
}
```

CodeWizard Output

```
[item06.C:6] Limiting the number of objects of a class
Informational: More Effective C++ item 26
```

Meyers-Klaus Items

Category	Item	Description	Violation	Enabled
Constructors/ Destructors/ Assignment	13	Avoid calling virtual functions from constructors and destructors.	SV	Y
Implementation	23	Avoid using "..." in function parameter list.	I	N

Item MK_13

Avoid calling virtual functions from constructors and destructors

CodeWizard can detect when you call virtual functions from constructors and destructors. These errors are reported as violations of Item MK_13.

Example

```
//
// Meyers-Klaus Item 13
//

class Base
{
public:
    Base() { init(); }            // MK item 13 violation
    virtual ~Base();

protected:
    virtual void init();
    int _i;
};

void Base::init()
{
    _i = 10;
}


class Derived : public Base
```

```
{
public:
    Derived() { init(); }         // MK item 13 violation
    ~Derived();

private:
    void init();
};

void Derived::init()
{
    _i = 20;
}


int main()
{
    return 0;
}
```

CodeWizard Output

```
[MK-item13.C:8] Avoid calling virtual functions from
constructors and destructors
Severe violation: Meyers-Klaus item 13
Virtual function init called.

[MK-item13.C:25] Avoid calling virtual functions from
constructors and destructors
Severe violation: Meyers-Klaus item 13
Virtual function init called.
```

Item MK_23

Avoid using “...” in function parameter lists

CodeWizard can detect when you use “...” in function parameter lists. These errors are reported as violations of Item MK_23.

Note: This item is suppressed by default.

Example

```
//
// Meyers-Klaus Item 23
//

class A
{
public:
    A() { init(); }
    virtual ~A();

private:
    void init(...);
    int _i;
};

void A::init(...)
{
    _i = 10;
}
```

```
int main()
{
    return 0;
}
```

CodeWizard Output

```
[MK-item23.C:17] Avoid using "..." in function
parameter list
Informational: Meyers-Klaus item 23
```

Universal Coding Standard Items

Item	Description	Violation	Enabled
2	Do not declare protected data members.	V	No
3	Do not declare the constructor or destructor to be inline.	V	No
4	Declare at least one constructor to prevent the compiler from doing so.	V	No
5	Pointers to functions should use a typedef.	V	No
6	Never convert a const to a non-const.	SV	Yes
7	Do not use the ?: operator.	V	No
8	Each class must declare the public, protected, and private sections in that order.	V	No
9	In the public section entities shall be declared in the following order: Constructors, Destructors, Member functions, Member conversion functions, Enumerations, and other.	V	No

10	In the protected section entities shall be declared in the following order: Constructors,Destructors, Member functions, Member conversion functions, Enumerations, and others.	V	No
11	In the private section entities shall be declared in the following order: Constructors, Destructors, Member functions, Member conversion functions, Enumerations, and others.	V	No
12	If a function has no parameters, use () instead of (void).	V	No
13	If, else, while, and do statements shall be followed by a block, even if it is empty.	V	No
14	If a block is a single statement, enclose it in braces.	V	No
15	Whenever a global variable or function is used, use the :: operator.	I	No
16	Do not use public data members.	V	No
17	If a class has any virtual functions it shall have a virtual destructor.	SV	Yes
18	Public member functions shall return const handles to member data.	SV	Yes

19	A class that has pointer members shall have an operator= and a copy constructor.	V	No
20	If a subclass implements a virtual function,use the virtual keyword.	V	No
21	Member functions shall not be defined in the class definition.	V	No
22	Ellipses shall not be used.	V	No
23	Functions shall explicitly declare their return types.	V	No
24	A pointer to a class shall not be converted to a pointer of a second class unless it inherits from the second.	SV	Yes
25	A pointer to an abstract class shall not be converted to a pointer that inherits from that class.	SV	Yes
26	Do not use the friend mechanism.	V	No
27	When working with float or double values, use <= and => instead of ==.	SV	Yes
28	Do not overload functions within a template class.	SV	Yes
29	Do not define structs that contain member functions.	V	No
30	Do not directly access global data from a constructor.	SV	Yes

31	Do not use multiple inheritance.	V	No
32	Initialize all variables.	V	No
33	All pointers should be initialized to zero.	V	No
34	Always terminate a case statement with break.	V	No
35	Always provide a default branch for switch statements.	V	No
36	Do not use the goto statement.	V	No
37	Provide only one return statement in a function.	I	No

Item ucs_02

Do not declare protected data members

Declaring protected variables in a class results in the variables becoming visible to derived classes. CodeWizard can detect if you declare protected data members. These errors are reported as violations of Item ucs_02.

Reason for rule: When you declare data members protected instead of private, you expose members to derived classes that could be encapsulated in member functions.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 02 - Do not declare protected data members
3:  * /
4: class A
5: {
6: protected:
7:       int i;                    // UCS02 Violation
8: };
```

CodeWizard Output

```
[ucs02.C:6] Do not use protected data members
Violation: Universal Coding Standards item 2
Class A declares the following protected data members:
i
```

Item ucs_03

Do not declare the constructor or destructor to be inline

Inline functions that invoke other inline functions can be too complex for the compiler to make them inline. Because constructors always invoke the constructors of their base classes and member data, CodeWizard reports use of inline constructors and destructors as violations of Item ucs_03.

Reason for rule: Portability. Functions that invoke other inline functions often become too complex for the compiler to be able to make them inline, despite the fact that they appear to be small. This problem is especially common with constructors and destructors. A constructor always invokes the constructors of its base classes and member data before executing its own code. If you avoid making constructors and destructors inline, you will make the code more portable to compilers that get confused when generating complex nested inline functions.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 03 - Do not declare the constructor or
destructor to be inline
3:  * /
4: class A
5: {
6: public:
7:       A {}                        // UCS03 Violation
8:       ~A {}                       // UCS03 Violation
9: };
```

CodeWizard Output

```
[ucs03.C:6] Do not define any constructor to be inline
Violation: Universal Coding Standards item 3
Class A defines an inline constructor
```

Item ucs_04

Declare at least one constructor to prevent the compiler from doing so

If you do not write at least one constructor in a class, the compiler will write a public constructor for you by default. CodeWizard can detect if you do not declare at least one constructor and report these errors as violations of Item ucs_04.

Reason for rule: Readability. If you follow this rule, you will make class initialization explicit and prevent the compiler from initializing members improperly--especially pointer members.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 04 - Declare at least one constructor to
3:  * prevent the compiler from doing so
4:  * /
5: class A
6: {
7: };                                  // UCS04 Violation
```

CodeWizard Output

```
[ucs04.C:7] Declare at least one constructor to prevent the
compiler from doing so
Violation: Universal Coding Standards item 4
Class A does not define any constructors
```

Item ucs_05

Pointers to functions should use a typedef

Using a `typedef` when writing pointers to functions will result in more readable code that is easier to maintain and port. CodeWizard can detect when pointers to functions do not use a `typedef`. These errors are reported as violations of Item ucs_05.

Reason for rule: When you use a `typedef`, you provide greater readability for function pointers.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 05 -Pointers to functions should use a typedef
3:  * /
4: void (*foo) (int);      // UCS05 Violation
```

CodeWizard Output

```
[ucs05.C:7] Pointers to functions shall be implemented with
a typedef
Violation: Universal Coding Standards item 5
```

Item ucs_06

Never convert a const to a non-const

Using explicit type conversions to convert const member data to non-const will prevent the compiler from allocating constants in ROM. CodeWizard can detect if you convert a `const` to a `non-const`. These errors are reported as violations of Item ucs_06.

Reason for rule: Converting `const` to `non-const` can undermine the data integrity by allowing values to change that are assumed to be constant. This practice also reduces the readability of the code, since you cannot assume `const` variables to be constant.

Example

```
1: /*
2:  * UCS item 06 - Never convert a const to a non-const
3:  * /
4: int main()
5: {
6:       const int a = 10
7:       int b;
8:
9:       b = (int)a;               // UCS06 Violation
10: };
```

CodeWizard Output

```
[ucs06.C:10] Never convert a const to a non-const
Severe violation: Universal Coding Standards item 6
```

Item ucs_07

Do not use the ?: operator

Using the `?:` operator can make your code more difficult for others to read and understand. CodeWizard can detect if you use the `?:` operator. This error is reported as violations of Item ucs_07.

Reason for rule: The `?:` operator is difficult to read and leads to code obfuscation.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 07 - Do not use the ?: operator
3:  * /
4: int main()
5: {
6:       return (1 ? 1 : 0); // UCS07 Violation
7: };
```

CodeWizard Output

```
[ucs07.C:7] Avoid using the ?: operator
Violation: Universal Coding Standards item 7
```

Item ucs_08

Each class must declare the public, protected, and private sections in that order

Using the above convention, everything of general interest to a user (the public section) is gathered in the beginning of the class definition while items of the least general interest (the private section) are gathered last. CodeWizard reports violations of this convention as violations of Item ucs_08.

Reason for rule: Readability.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 08 - Each class must declare the public,
3:  * protected, and private sections in that order
4:  * /
5: class A
6: {
7: public:
8:      );
9:
10: private:                    // UCS08 Violation
11:     void foo();
12:
13: protected:
14:     void bar();
```

```
15: };
```

CodeWizard Output

```
[ucs08.C:7] Each class must declare the public,
protected, and private sections in that order
Violation: Universal Coding Standards item 8
class A declares these sections out of order.
```

Item ucs_09

In the public section, entities shall be declared in the following order: Constructors, Destructors, Member functions, Member conversion functions, Enumerations, and other

Following the above ordering convention will make it easier for those unfamiliar with a class to figure out its functionality. CodeWizard reports violations of this convention as violations of Item ucs_09.

Reason for rule: Readability.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 09 - In the public section entities shall be declared in the
3:  *    following order:  Constructors, Destructors, Member
4:  *     functions, Member conversion functions,
5:  *     Enumerations, and other
6:  * /
7: class A
8: {
9: public:
10:      );
11:      int foo();                // UCS09 Violation
12:      );
13: };
```

CodeWizard Output

```
[ucs09.C:9] In the public section of a class items shall be
declared in the following order: Constructors, Destructor,
Member Functions, Member Operator Function, Enumerations,
other

Violation: Universal Coding Standards item 9
```

Item ucs_10

In the protected section entities shall be declared in the following order: Constructors, Destructors, Member functions, Member conversion functions, Enumeration, and other

Following the above ordering convention will make it easier for those unfamiliar with a class to figure out its functionality. CodeWizard reports violations of this convention as violations of item ucs_10.

Reason for rule: Readability.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 10 - In the protected section entities shall
3:  * be declared in the following order:  Constructors,
4:  * Destructors, Member functions, Member conversion
5:  * functions, Enumerations, and other
6:  * /
7: class A
8: {
9: protected:
10:      );
11:      int foo();                // UCS10 Violation
12:      );
13: };
```

CodeWizard Output

```
[ucs10.C:9] In the protected section of a class items shall
be declared in the following order: Constructors,
Destructor, Member Functions, Member Operator Function,
Enumerations, other

Violation: Universal Coding Standards item 10
```

Item ucs_11

In the private section entities shall be declared in the following order: Constructors, Destructors, Member functions, Member conversion functions, Enumerations, and other

Following the above ordering convention will make it easier for those unfamiliar with a class to figure out its functionality. CodeWizard can detect if you declare entities in the private section in the wrong order. These errors are reported as violations of Item ucs_11.

Reason for rule: Readability.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 11 - In the private section entities shall
3:  * be declared in the following order:  Constructors,
4:  * Destructors, Member functions, Member conversion
5:  * functions, Enumerations, and other
6:  * /
7: class A
8: {
9: private:
10:      );
11:      int foo();                // UCS11 Violation
12:      );
13: };
```

CodeWizard Output

```
[ucs11.C:9] In the private section of a class items shall be
declared in the following order: Constructors, Destructor,
Member Functions, Member Operator Function, Enumerations,
other

Violation: Universal Coding Standards item 11
```

Item ucs_12

If a function has no parameters, use () instead of (void)

CodeWizard can detect if you use `(void)` instead of `()` if a function has no parameters. Maintaining this consistency of declarations will result in easier code readability. These errors are reported as violations of Item ucs_12.

Reason for rule: Readability.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 12 - If a function has no parameters use () instead of (void)
3:  * /
4: int foo(void);                  // UCS12 Violation
```

CodeWizard Output

```
[ucs12.C:5] If a function has no formal parameters, use () instead of (void)
Violation: Universal Coding Standards item 12
function foo uses (void).
```

Item ucs_13

If, else, while, and do statements shall be followed by a block, even if it is empty

To avoid confusion when reading a piece of code, you should follow loop statements with an empty block rather than with a semi-colon, which is easy to miss. CodeWizard can detect if you do not follow `If`, `else`, `while`, and `do` statements with a block. These errors are reported as violations of Item ucs_13.

Reasons for rule: Readability and maintainability. (See UCS 14.) This rule also helps to prevent errors such as:

```
while(1); { // infinite loop
    do_something();
}
```

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 13 - If, else, while, and do statements shall
3:  * be followed by a block, even if it is empty
4:  * /
5: int main()
6: {
7:       if (1) ;                  // UCS13 Violation
8:       return 0;
9: }
```

CodeWizard Output

```
[ucs13.C:8] If, else, while, and do statements shall be
followed by a block, even if it is empty

Violation: Universal Coding Standards item 13
```

Item ucs_14

If a block is a single statement, enclose it in braces

To avoid causing confusion for people who are reading a piece of your code, you should always enclose a single-statement block in braces. CodeWizard can detect if single-statement blocks are not enclosed in braces. These errors are reported as violations of Item ucs_14.

Reasons for rule: Readability and maintainability. If you are maintaining the code and you see this:

```
if (condition)
    do_something();
```

you may be tempted to update it like this:

```
if (condition)
    do_preparation();
    do_something();
```

instead of like this:

```
if (condition) {
    do_preparation();
    do_something();
}
```

If you write the original code like this:

```
if (condition) {
    do_something();
}
```

there will be less room for error for the maintainer of the code.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 14 - If a block is a single statement,
enclose it in braces
3:  * /
4: int main()
5: {
6:       if (1)
7:            return 1;            // UCS14 Violation
8: }
```

CodeWizard Output

```
[ucs14.C:7] If a block is a single statement, it shall be
enclosed in braces
Violation: Universal Coding Standards item 14
```

Item ucs_15

Whenever a global variable or function is used, use the : : operator

CodeWizard can detect if you do not use the : : operator whenever a global variable or function is used. Using the : : operator in these situations will make it easier to determine which variable is being used while code is being read. These errors are reported as violations of Item ucs_15.

Reasons for rule: Readability and maintainability. Using the : : operator helps the maintainer of code to distinguish quickly between global variables and local variables, and it gives the maintainer more freedom with local variable names without colliding with global names.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 15 - Whenever a global variable or function is
used,
3:  *                 use the :: operator
4:  * /
5: int a = 10;
6: int main()
7: {
8:       int b = a;                // UCS15 Violation
9: }
```

CodeWizard Output

```
[ucs15.C:9] Whenever a global function or variable is
referenced, use the :: operator
```

Informational: Universal Coding Standards item 15

the following globals are referenced without the :: operator.

a

Item ucs_16

Do not use public data members

Using public variables is contrary to the principle of data encapsulation and can allow the value of the variable to be changed by any user of the class. CodeWizard can detect if you use public data members. These errors are reported as violations of Item ucs_16.

Reason for rule: Data hiding. If you follow this rule, you will insulate the class interface from the class implementation. You will also provide consistency for users of the class to access data through member functions every time. Internally, the class may change which data types are used to store the data without breaking the interface.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 16 - Do not use public data members
3:  * /
4: class A
5: {
6: public:
7:       int a;                    // UCS16 Violation
8: };
```

CodeWizard Output

```
[ucs16.C:6] Do not specify public data members
Violation: Universal Coding Standards item 16
Class A has the following public data members:
a
```

Item ucs_17

If a class has any virtual functions it shall have a virtual destructor

Declaring virtual destructors in classes that have virtual functions causes the compiler to call destructors for each class from which the object inherits. CodeWizard can detect if you write a virtual function without also writing a virtual destructor. These errors are reported as violations of Item ucs_17.

Reason for rule: Prevents memory leaks in derived classes. A class that has any virtual functions is intended to be used as a base class, so it should have a virtual destructor to guarantee that the destructor will be called when the derived object is referenced through a pointer to the base class.

Example

```
1: /*
2:  * UCS item 17 - If a function has any virtual functions
it shall
3:  *                 have a virtual destructor
4:  * /
5: class A                          // UCS17 Violation
6: {
7: public:
8:       );
9:       virtual int foo();
10: };
```

CodeWizard Output

```
[ucs17.C:7] If a class has virtual functions it shall have a
```

```
virtual destructor
Severe violation: Universal Coding Standards item 17
class A has virtual functions without a virtual destructor.
```

Item ucs_18

Public member functions shall return const handles to member data

This item will help you avoid having problems that point to deallocated memory. CodeWizard reports any public member functions that do not return `const` handles to member data as violations of Item ucs_18.

Reason for rule: When you provide `non-const` handles to member data, you undermine encapsulation by allowing callers to modify member data outside of member functions.

Example

```
1: /*
2:  * UCS item 18 - Public member functions shall return
const handles
3:  *                 to member data
4:  * /
5: class A
6: {
7: public:
8:       int foo();
9:
10: private:
11:      int a;
12: };
13: int A::foo()
14: {
15:      return a;                  // UCS18 Violation
16: }
```

CodeWizard Output

```
[ucs18.C:17] Public member functions shall always return
const handles to member data

Severe violation: Universal Coding Standards item 18
```

Item ucs_19

A class that has pointer members shall have an operator= and a copy constructor

Default memberwise initialization is generally insufficient for classes that contain pointer members because the destructor is invoked for every class object, which may result in dangling references and other program errors. CodeWizard can detect if classes that have pointer members do not also have an `operator=` and a copy constructor. These errors are reported as violations of Item ucs_19.

Reason for rule: Prevents memory leaks and data corruption. If you do not define a copy constructor, the default constructor will be used, which is usually not the desired behavior when a class has pointer members.

Note: This item is suppressed by default.

Example

```
/*
 * UCS item 19 - A class that has pointer members shall have
 * an operator=and a copy constructor
 */

class A
{
public:
    A();
    ~A();

private:
    int *a;
```

```
};                  // UCS19 Violation
```

CodeWizard Output

```
[ucs19.C:7] If a class has pointer members it must define a
copy constructor and op=
Violation: Universal Coding Standards item 19
```

Item ucs_20

If a subclass implements a virtual function, use the virtual keyword

Using the virtual keyword whenever a subclass implements a virtual function will make the code more readable, because the reader will not have to refer back to the base class to see that the function is virtual. CodeWizard can detect if a subclass implements a virtual function without using a virtual keyword. These errors are reported as violations of Item ucs_20.

Reasons for rule: Readability, and more intuitive behavior for deep inheritance hierarchies in that functions that are virtual in a base class will remain virtual in all inherited classes.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 20 - If a subclass implements a virtual
3:  * function, use the virtual keyword
4:  * /
5: class B
6: {
7: public:
8:       virtual int foo();
9: };

10: class D
11: {
12: public:
13:      int foo();                // UCS20 Violation
```

```
14: };
```

CodeWizard Output

```
[ucs20.C:12] If a subclass redefines a virtual function, use
the keyword virtual in that function's declaration
Violation: Universal Coding Standards item 20
```

Item ucs_21

Member functions shall not be defined in the class definition

Functions defined within the class definition are implicitly inline. Defining member functions within a class definition will also make the class definition less compact and harder to read. CodeWizard can detect if you define member functions in the class definition. These errors are reported as violations of Item ucs_21.

Reason for rule: Encourages better data hiding by separating interface and implementation.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 21 - Member functions shall not be defined in
3:  * the class definition
4:  * /
5: class A
6: {
7: public:
8:       int foo() {};             // UCS21 Violation
9: };10: class D
11: {
12: public:
13:      int foo();                // UCS20 Violation
14: };
```

CodeWizard Output

```
[ucs21.C:7] Member functions shall not be defined within the
class definition

Violation: Universal Coding Standards item 21

class A defines the following functions within the class
definition

foo
```

Item ucs_22

Ellipses shall not be used

Developers should avoid using unspecified function arguments (...) because this deters the strong type checking provided by C++. CodeWizard can detect if you use ellipses. These errors are reported as violations of Item ucs_22.

Reason for rule: Ellipses defeat the benefits of type safety. Use default arguments instead.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 22 - Ellipses shall not be used
3:  * /
4: class A
5: {
6: public:
7:       int foo(int, ...); // UCS22 Violation
8: };
```

CodeWizard Output

```
[ucs22.C:8] Ellipses shall not be used
Violation: Universal Coding Standards item 22
function foo uses ellipses.
```

Item ucs_23

Functions shall explicitly declare their return types

If return types are not explicitly declared, functions will implicitly receive `int` as the return type. However, the compiler will still generate a warning for a missing return type. To avoid confusion, functions that do not return a value should specify `void` as the return type.

CodeWizard can detect if you do not explicitly declare return types in functions. These errors are reported as violations of Item ucs_23.

Reason for rule: Readability. If you do not specify a return type, the compiler will assume either `void` or `int`, depending on the compiler. You should explicitly declare the return type so that the result will be unambiguous.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 23 - Functions shall explicitly declare their
return types
3:  * /


4: foo();                  // UCS23 Violation
```

CodeWizard Output

```
[ucs23.C:5] Functions shall explicitly declare their return
type
Violation: Universal Coding Standards item 23
```

Item ucs_24

A pointer to a class shall not be converted to a pointer of a second class unless it inherits from the second

CodeWizard can detect if a pointer to a class is converted to a pointer of a second class when the first class does not inherit from the second. Such "invalid" downcasting can result in wild pointers and other disasters. Use virtual function calls instead. These errors are reported as violations of Item ucs_24.

Reason for rule: If you violate this rule, you make assumptions about member layout of classes that may be subject to change, producing memory and data corruption bugs.

Example

```
1: /*
2:  * UCS item 24 - A pointer to a class shall not be converted to a pointer
3:  * of a second class unless it inherits from the second
4:  * /
5: class A {};
6: class B {};
7: int main()
8: {
9:       A a;
10:      B b;
11:
12:      b = (b)a;                  // UCS24 Violation
```

```
13: }
```

CodeWizard Output

```
[ucs24.C:14] A pointer to a class may not be converted to a
pointer of a second class unless the first class inherits
from the second

Severe violation: Universal Coding Standards item 24
```

Item ucs_25

A pointer to an abstract class shall not be converted to a pointer that inherits from that class

Downcasting from a virtual base is always illegal. CodeWizard can detect pointers to abstract classes that are converted to pointers that inherit from that class. These errors are reported as violations of Item ucs_25.

Reason for rule: When appropriate functions are virtual, converting them is unnecessary and confusing.

Example

```
1: /*
2:  * UCS item 25 - A pointer to an abstract class shall not
be converted
3:  * to a pointer that inherits from that class
4:  * /
5: class B
6: {
7: public:
8:       int foo() = 0;
9: };
10: class D : public B
11: {
12: public:
13:      int foo();
14: };
15: int main()
16: {
```

```
17:      B b;
18:      D d;
19:
20:      d = (d)b;                  // UCS25 Violation
21: }
```

CodeWizard Output

```
[ucs25.C:23] A pointer to an abstract class shall not be
converted to a pointer of a class that inherits from the
abstract class

Severe violation: Universal Coding Standards item 25
```

Item ucs_26

Do not use the friend mechanism

Using friend functions is usually a sign of an inadequate interface. Fixing the interface, rather than granting friendship, is the best approach. CodeWizard can detect if you use the friend mechanism. These errors are reported as violations of Item ucs_26.

Reason for rule: Using the friend mechanism undermines data-hiding and encapsulation.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 26 - Do not use the friend mechanism
3:  * /

4: int foo();

5: class A
6: {
7:       friend int foo();          // UCS26 Violation
```

CodeWizard Output

```
[ucs26.C:8] Avoid using the friend mechanism
Violation: Universal Coding Standards item 26
Class A has the following friends:
foo
```

Item ucs_27

When working with float or double values, use <= and => instead of ==

Two different paths to the same number won't always lead to the same number. This means, for example, that floating-point numbers that should be equal are not always equal. Using <= and >= instead of == is the recommended solution to the problem.

CodeWizard can detect if you use == when working with `float` or `double` values. These errors are reported as violations of Item ucs_27.

Reason for rule: Using <= and => helps prevent rounding errors.

Example

```
1: /*
2:  * UCS item 27 - When working with float or double
3:  *    values, use <= and => instead of ==
4:  * /
5: int main()
6: {
7:       float a = 1.0;
8:       float b = 2.0;
9:
10:      if (a == b) {              // UCS27 Violation
11: return 1;
12:      }
13:
14:      return 0;
15: }
```

CodeWizard Output

```
[ucs27.C:11] When working with float or double expressions,
use less than or equal to or greater than or equal to instead
of ==

Violation: Universal Coding Standards item 27
```

Item ucs_28

Do not overload functions within a template class

Overloading functions within a template class can lead to problems if the element type appears explicitly in one of them. CodeWizard can detect if you overload functions within a template class. These errors are reported as violations of Item ucs_28.

Reason for rule: Overloading functions may indicate a design flaw in the template class.

Example

```
1: /*
2:  * UCS item 28 - Do not overload functions within a
template class
3:  * /
4: template <class T> class A
5: {
6: public:
7:       int foo(T);
8:       int foo(int);              // UCS28 Violation
9: };
```

CodeWizard Output

```
[ucs28.C:6] Do not overload functions within a template
class
Severe violation: Universal Coding Standards item 28
The following member functions of class A
foo
```

have potentially conflicting overloaded versions

Item ucs_29

Do not define structs that contain member functions

Member functions should be contained in classes, not structs, because classes support both multiple instances and encapsulation. Structs are also often entirely `public:` whereas the default access level for members and base classes of a class is `private`.

CodeWizard can detect if you define structs that contain member functions. These errors are reported as violations of Item ucs_29.

Reason for rule: Readability. People generally expect types with member functions to be classes, and they still think of structs in terms of their original meaning in C.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 29 - Do not define structs that contain member
functions
3:  * /
4: struct A
5: {
6: public:
7:       int foo();                // UCS29 Violation
8: };
```

CodeWizard Output

```
[ucs29.C:6] Do not define structs that contain objects with
member functions
```

```
Violation: Universal Coding Standards item 29
struct A contains the following member functions:
foo
```

Item ucs_30

Do not directly access global data from a constructor

Directly accessing global data from a constructor is risky because the global object may not yet exist when the "other" static object is initialized. CodeWizard can detect if you directly access global data from a constructor. These errors are reported as violations of Item ucs_30.

Reason for rule: The order of initialization of static objects defined in different compilation units is not defined in the C++ language definition. Therefore, accessing global data from a constructor may result in reading from uninitialized objects.

Example

```
1: /*
2:  * UCS item 30 - Do not directly access global data from a
constructor
3:  * /
4: int a;
5: class A
6: {
7: public:
8:       );
9: private:
10:      int b;
11: };
12: :A()
13: {
14:      b = a;                    // UCS30 Violation
15: }
```

CodeWizard Output

```
[ucs30.C:8] Do not directly access global data from a
constructor

Severe violation: Universal Coding Standards item 30

Constructor accesses the following global variables:

a
```

Item ucs_31

Do not use multiple inheritance

Using multiple inheritances can result in strange class hierarchies and less flexible code. Because in C++ there may be an arbitrary number of instances of a given type, it could be that direct inheritance from a class may only be used once (for instance, see the example below). CodeWizard can detect if you use multiple inheritance. These errors are reported as violations of Item ucs_31.

Reasons for rule: Clarity, maintainability. Following this rule prevents ambiguity when classes derive from one object through multiple objects as in the “diamond of death.”

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 31 - Do not use multiple inheritance
3:  * /
4: class B {};
5: class A : public B {};
6: class C : public B {};
7: class D : public A, public C {};// UCS31 Violation
```

CodeWizard Output

```
[ucs31.C:8] Do not use multiple inheritance
Violation: Universal Coding Standards item 31
class D inherits multiply from the following classes:
A
C
```

Item ucs_32

Initialize all variables

A variable must always be initialized before it is used. By always initializing all variables, rather than assigning values to them before they are first used, you can make your code faster and more efficient since no temporary objects are created for the initialization.

CodeWizard can detect if you fail to initialize all variables. These errors are reported as violations of Item ucs_32.

Reason for rule: Following this rule prevents reading from uninitialized variables.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 32 - Initialize all variables
3:  * /
4: int main()
5: {
6: public:
7:       int a;                    // UCS32 Violation
8: };
```

CodeWizard Output

```
[ucs32.C:6] Initialize all variables
Violation: Universal Coding Standards item 32
The following variables were not initialized when declared:
a
```

Item ucs_33

All pointers should be initialized to zero

Initializing pointers to zero makes the code more efficient and also helps you catch signals and exceptions. CodeWizard can detect if you do not initialize all pointers to zero. These errors are reported as violations of Item ucs_33.

Reason for rule: Initializing pointers to zero makes it easier to check if a pointer is valid.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 33 - All pointers should be initialized to
zero
3:  * /
4: int main()
5: {
6:       int *a;                    // UCS33 Violation
7: };
```

CodeWizard Output

```
[ucs33.C:6] All pointers should be initialized to zero
Violation: Universal Coding Standards item 33
The following pointers were not initialized when declared:
a
```

Item ucs_34

Always terminate a case statement with break

If the code following a case statement is not terminated with break, execution continues after the next case statement, meaning poorly tested code can be erroneous and still appear to work. CodeWizard can detect if you fail to terminate a `case` statement with `break`. These errors are reported as violations of Item ucs_34.

Reasons for rule: Readability, maintainability.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 34 - Always terminate a case statement with
break
3:  * /
4: int main()
5: {
6:       int a = 0;
7:
8:       switch (a) {
9:       case 0:
10:               return 0;
11:      case 1:
12:               a = 1;            // UCS34 Violation
13:      }
14: }
```

CodeWizard Output

```
[ucs34.C:13] Always terminate a case statement with break
Violation: Universal Coding Standards item 34
```

Item ucs_35

Always provide a default branch for switch statements

`Switch` statements must always provide a default branch that handles unexpected cases. CodeWizard can detect if you fail to provide a default branch for `switch` statements. These errors are reported as violations of Item ucs_35.

Reason for rule: Maintainability. If all desired cases are handled outside of default, then default can be used for error checking.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 35 - Always provide a default branch for
switch statements
3:  * /
4: int main()
5: {
6:       int a = 0;
7:
8:       switch (a) {
9:       case 0:
10:               return 0;
11:      case 1:
12:               return 1;
13:      }                        // UCS35 Violation
14: }
```

CodeWizard Output

```
[ucs35.C:9] Always provide a default branch for switch
statements

Violation: Universal Coding Standards item 35
```

Item ucs_36

Do not use the goto statement

The `goto` statement interrupts the control flow, makes the code more difficult to understand, and has limits on when it can be used. CodeWizard can detect if you use the `goto` statement. These errors are reported as violations of Item ucs_36.

Reasons for rule: Readability, maintainability. Anything written with a `goto` can be written more clearly without a `goto`.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 36 - Do not use the goto statement
3:  * /
4: int main()
5: {
6:       goto end;                  // UCS36 Violation
7:
8: end:
9:       return 0;
10: }
```

CodeWizard Output

```
[ucs36.C:7] Do not use the goto statement
Violation: Universal Coding Standards item 36
```

Item ucs_37

Provide only one return statement in a function

Minimizing the number of return statements in a function makes the function easier to understand. CodeWizard can detect if you provide more than one return statement in a function. These errors are reported as violations of Item ucs_37.

Reasons for rule: Readability, maintainability, debugging. It is easier to follow the program flow if there is only one return statement.

Note: This item is suppressed by default.

Example

```
1: /*
2:  * UCS item 37 - Provide only one return statement in a
function
3:  * /
4: int main()
5: {
6:       if (0) {
7:                return 0;
8:       } else {
9:                return 1;         // UCS37 Violation
10:      }
11: }
```

CodeWizard Output

```
[ucs37.C:6] Provide only one return statement in a function
Informational: Universal Coding Standards item 37
```

User Items

(Version 3.x only)

User items are C and C++ coding standards that you have created or that you can customize.

There are two types of user items:

- Coding standards that you have designed in RuleWizard.
- Coding standards written by ParaSoft that can be modified/customized in RuleWizard. These rules are divided into three categories:
    - **Naming Convention:** Rules in the 100-199 range are Naming Conventions and have names beginning with "Name." These rules do not represent code which is dangerous or incorrect; rather, they are schemes for naming variables, functions, classes, etc. When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

      A common element in the Naming Conventions rules is the use of regular expressions. The regular expression format is based on that used in Perl. These regular expressions can be modified to enforce whatever Naming Convention your development group agrees on.
    - **Metrics:** Rules in the 600-699 section are Metrics and have names beginning with "Metric." These rules have a slightly different usage than other CodeWizard rules. Whereas most CodeWizard rules are designed to find patterns which represent bad programming practices, the metrics rules are used primarily to produce numbers representing size and complexity of code. Because of this, most outputs in the metrics rules include a "$count" expression in the Output, which prints the number of occurrences found of that particular pattern. The collectors have count expressions which should be modified according to what cut-off point you are interested in seeing.

For example, MetricInheritance.rule reports the number of classes which a given class derives from directly or indirectly. The default is to report this on classes where the ancestor count is greater than 10. If you want a report on the ancestors for every class, set the count expression to "$$>=0". Likewise, if you only want it to report on classes which derive from over 20 base classes, change the count expression to "$$>20".

For a discussion of what metrics are and how to use them, see Mark Shroeder's article, "A Practical Guide to Object-Oriented Metrics" in IT Pro, November/December, 1999.

- **C Rules:** Rules in the 700-799 range are rules that were designed especially for C developers.
- **Miscellaneous:** Rules in the 200-599 range are miscellaneous C and C++ coding standards that users can customize.

Violations of user items are labeled “user-<item number>”.

You can suppress individual user rules or all user rules as you would suppress rules in any other category.

You can also enable/disable these rules by checking or clearing options in the Control Panel’s Rules tab.

For more information on creating, modifying, and enforcing custom coding standards, open RuleWizard by clicking the **RuleWizard** button in the CodeWizard Visual C++ Toolbar, then choose **Help> RuleWizard Documentation** in the RuleWizard GUI to open the RuleWizard Users Guide.

For a description of built-in user rules, choose **Help> Rule Documentation** in the RuleWizard GUI.

Rule	Description	Violation	Enabled	C/C++
ArrayElementAccess	Array elements shall be accessed by the array operator [ ]	V	N	C/C++
AssignAllMemberVar	Assign to all member variables in operator= functions	V	N	C++
AssignCharTooHigh	Do not use constants that are greater than the char type's legal range	V	N	C/C++
AssignCharTooLow	Do not use constants that are less than the char type's legal range	V	N	C/C++
AssignUnCharTooHigh	Do not use constants that are greater than the unsigned char type's legal range	V	N	C/C++
AssignUnCharTooLow	Do not use constants that are less than the unsigned char type's legal range	V	N	C/C++
AssignmentOperator	Declare an assignment operator for each class with pointer member variables	V	N	C++

Rule	Description	Violation	Enabled	C/C++
BaseDestructors	Make destructors virtual for all base classes	V	N	C++
BitwiseInCondition	Do not use bitwise operator in conditional	PV	N	C/C++
BreakInForLoop	Avoid breaks in for loops	SV	N	C/C++
CastFuncPtrToPrimPtr	Do not cast a pointer to a function to a pointer of primitive type	V	N	C/C++
CastPointer	Do not cast pointers to non-pointers	V	Y	C/C++
CastUnsigned	Do not cast an unsigned pointer to an unsigned int	V	Y	C/C++
CharCompare	Do not compare chars to constants out of char range	SV	Y	C/C++
CharacterTest	Use the ctype.h facilities for character test	PV	N	C/C++
CommaOperator	The comma operator shall only be used in for statements and variable declarations	V	N	C/C++
ConstParam	Declare reference parameters as const reference whenever possible	V	N	C/C++

Rule	Description	Violation	Enabled	C/C++
ConstPointerFunction Call	Const data type should be used for pointers in function calls if the pointer will not be modified	V	N	C/C++
DeclDimArray	Don't declare the magnitude of an array declaration	PV	N	C/C++
DeclareArrayMagnitude	Don't declare the magnitude of a single dimensional array in the parameter declaration	V	N	C/C++
DeclareBitfield	Do not declare member variables as bitfields	I	N	C/C++
DeclareExplicit Constructor	Do not use the keyword 'explicit' for a constructor	I	N	C/C++
DeclareMutable	Do not declare member variables with the 'mutable' keyword	I	N	C++
DeclareRegister	Do not declare local variables with the 'register' keyword	I	N	C/C++
DeclareStaticLocal	Do not declare local variables with the 'static' keyword	I	N	C/C++
DeleteIfNew	Write operator delete if you write operator new	V	N	C++

Rule	Description	Violation	Enabled	C/C++
DeleteNonPointer	Do not call delete on a non-pointer	SV	Y	C++
DoWhile	Avoid do statements	I	Y	C/C++
EnumKeyword	Do not use an enum keyword to declare a variable in C++	I	N	C++
EnumNamingConvention	In an enumerated list, list members (elements) shall be in uppercase and names or tags for the list shall be in lower-case	PV	N	C/C++
EqualityFloat	Do not check floats for equality; check for greater than or less than	SV	Y	C/C++
ExplicitEnumValues	When using enum, the values of each member should be explicitly declared	PV	N	C/C++
ExplicitLogicalTest	Use explicit logical tests in conditional expressions	V	N	C/C++
ExprInSizeof	Avoid expressions in sizeof operator	V	N	C/C++
FileNameConvention	Use lowercase for file names	PV	N	C/C++
ForLoopVarAssign	Do not assign to loop control variables in the body of a for loop	V	N	C/C++

Rule	Description	Violation	Enabled	C/C++
FractionLoss	Do not assign the dividend of 2 ints to a float	V	Y	C/C++
FuncModifyGlobalVar	Avoid functions that modify the global variable	V	N	C/C++
FunctionSize	Avoid functions over 50 lines	I	N	C/C++
GlobalPrefixExclude	Only use global prefixes for global variables	I	N	C/C++
GlobalVarFound	Avoid global variables	I	N	C/C++
HeaderInitialization	Headers should not contain any initialization	PV	N	C/C++
IfAssign	Avoid assignment in if statement condition	SV	Y	C/C++
IfElse	Give each if statements an else clause	I	N	C/C++
ImplicitUnsignedInit	Do not initialize unsigned integer variables with signed constants	V	N	C/C++
InitCharOutOfRange	Avoid constants out of range for the char type	V	N	C/C++
InitPointerVar	Initialize all pointer variables	V	N	C/C++

Rule	Description	Violation	Enabled	C/C++
InitUnCharOutOfRange	Avoid constants out of range for the unsigned char type	V	N	C/C++
LocalVariableNames	Local variable names shall be proper lowercase	PV	N	C/C++
LongConst	Use capital “L” instead of lowercase “l” to indicate long	SV	Y	C/C++
ManyCases	Avoid switch statements with many cases	I	N	C/C++
MetricBlockofCode	Number of blocks of code per function	V	N	C++
MetricBreakEncap	Number of global variable references per member function	V	N	C++
MetricFuncCall	Number of function calls per function	V	N	C++
MetricInheritance	Number of base classes	V	N	C++
MetricMembers	Number of data members per class	V	N	C++
MetricMethod	Number of methods per class	V	N	C++
MetricParam	Number of parameters per method	V	N	C++
MetricPrivateMembers	Number of private data members per class	V	N	C++

Rule	Description	Violation	Enabled	C/C++
MetricPrivateMethod	Number of private methods per class	V	N	C++
MetricProtectedMembers	Number of protected data members per class	V	N	C++
MetricProtectedMethod	Number of protected methods per class	V	N	C++
MetricPublicMembers	Number of public data members per class	V	N	C++
MetricPublicMethod	Number of public methods per class	V	N	C++
ModifyInCondition	Do not use operator ++ or -- in the conditional part of if, while, or switch	PV	N	C/C++
NameBool	Begin boolean type variable names with ‘b’	I	N	C/C++
NameClass	Begin class names with an uppercase letter	I	N	C++
NameConflict	Avoid internal or external name conflict	V	N	C
NameConstantVar	Begin constant variable names with ‘c’	I	N	C/C++
NameDataMember	Begin class data member names with ‘its’	I	N	C++

Rule	Description	Violation	Enabled	C/C++
NameDouble	Begin double type variable names with ‘d’	I	N	C/C++
NameEnumType	Begin enumerated type names with an uppercase letter that is prefixed by the software element and suffixed by ‘_t_’	I	N	C/C++
NameFloat	Begin float type variable names with ‘f’	I	N	C/C++
NameFunction	Begin function names with an uppercase letter	V	N	C++
NameGlobalVar	Begin global variable names with ‘the’	I	N	C/C++
NameInt	Begin integer names with ‘i’	I	N	C/C++
NameIsFunction	Begin ‘is’ function names with bool values	I	N	C/C++
NameLongInt	Begin long integer value names with ‘li’	I	N	C/C++
NamePointerVar	Prefix variable type pointer names with ‘p’	I	N	C/C++
NameShortInt	Begin short integer variable names with ‘si’	I	N	C/C++

Rule	Description	Violation	Enabled	C/C++
NameSignedChar	Begin signed character variable names with ‘c’	I	N	C/C++
NameString	Begin terminated characters’ string variable names with ‘sz’	I	N	C/C++
NameStructType	Begin struct type names with an uppercase letter that is prefixed by software element and suffixed by ‘_t’	I	N	C/C++
NameUnsignedChar	Begin unsigned character type names with ‘uc’	I	N	C/C++
NameUnsignedInt	Begin unsigned integer type variables with ‘ui’	I	N	C/C++
NameVariable	Begin variable names with a lowercase letter	I	N	C/C++
NamingStructUnionMembers	Use lowercase letters for structure and union member names	PV	N	C/C++
NonScalarTypedefs	Append names of non-scalar typedefs with "_t"	PV	N	C/C++
NumberFunctionParam	Avoid functions with more than 5 parameters	V	N	C/C++

Rule	Description	Violation	Enabled	C/C++
OpEqualThis	Return reference to *this in operator= functions	SV	N	C++
PassByValue	Pass built-in types by value unless you are modifying them	V	N	C/C++
PointerParam Dereference	Don't dereference possibly null pointer parameters	PV	N	C
PublicInterface	Avoid member variables in the public interface	I	N	C++
ReferenceInitialization	Do not initialize a reference to refer to an object whose address can be changed	PV	N	C++
SingularSwitch Statement	Avoid switch statements with only one case	PV	N	C/C++
SourceFileSize	Avoid source files that are longer than 500 lines	I	N	C/C++
SourceNaming Convention	Use the “.c” extension for source file names	I	N	C/C++
StructKeyword	Do not use a struct keyword to declare a variable in C++	I	N	C++
ThrowDestructor	Do not throw from within a destructor	V	Y	C++

Rule	Description	Violation	Enabled	C/C++
TooManyFields	Avoid structs, unions, or classes with more than 20 fields	I	N	C/C++
UnionFieldNotDefined	Define fields for union declarations	I	N	C/C++
UnnecessaryCast	Avoid unnecessary casts	V	N	C++
Unnecessary Equal	Avoid unnecessary “==true”s	I	N	C/C++
UnreachableCode	Do not use unreachable code	PV	N	C/C++
UnusedLocalVariable	Avoid unused local variables	PV	N	C/C++
UnusedParameter	Avoid unused parameters	PSV	N	C/C++
Unused PrivateMember	Avoid unused private member variables	V	N	C++
UsePositiveLogic	Use positive logic rather than negative logic whenever practical	PV	N	C/C++

ArrayElementAccess.rule

Array elements shall be accessed by the array operator [ ]

This rule checks whether array elements are accessed by the array operator [].

Reason for rule: Array elements should be accessed by the array operator [] rather than the dereference operator '*'. Access to array by the dereference operator '*' is cryptic and hides the real intention.

Example

```
void foo()
{
        int array[2];
        array[1] = 0; //OK
        *(array+1) = 0; //Violation
        *array = 0; //Violation
}
```

AssignAllMemberVar.rule

Assign to all member variables in operator= functions

This rule checks whether you assign to all member variables in `operator=` functions.

Reason for rule: Assigning to all member variables in `operator=` functions prevents data corruption.

Example

```
class Foo {
public:
  Foo& operator=(const Foo& rhs) {
     if (&rhs == this) {
         return *this;
     }
     x = f.x;
     y = f.y;
     // violation, z is not assigned
     return *this;
   }
private:
  int x;
  int y;
  int z;
};
```

AssignCharTooHigh.rule

Do not use constants that are greater than the char type's legal range

This rule checks whether constants are greater than the char type’s legal range.

Reason for rule: The range of legal values for the char type is -128 to 127.

Example

```
/*
Range of values of char type is -128 to 127.
*/

void Foo()
{
        char c1 = 0;
        c1 = 145; // hit
        // ...
        return;
}
```

AssignCharTooLow.rule

Do not use constants that are less than the char type's legal range

This rule checks whether constants are less than the char type’s legal range.

Reason for rule: The range of legal values for char type is -128 to 127.

Example

```
/*
Range of values of char type is -128 to 127.
Violation if value is less than -128.
*/
void Foo()
{
        char uVal = 0;
        uVal = -133; // hit
        // ...
        return;
}
```

AssignUnCharTooHigh.rule

Do not use constants that are greater than the unsigned char type's legal range

This rule checks whether constants are grater than the unsigned char type’s legal range.

Reason for rule: The range of legal values for char type is 0 to 255.

Example

```
/*
Range of values of unsigned char type is 0 to 255.
Violation if assignment is too high.
*/

void Foo()
{
        unsigned char uVal = 0;
        uVal = 289;
        // ...
        return;
}
```

AssignUnCharTooLow.rule

Do not use constants that are greater than the unsigned char type's legal range

This rule checks whether constants are greater than the unsigned char type’s legal range.

Reason for rule: The range of legal values for the char type is 0 to 255.

Example

```
/*
Range of values of unsigned char type is 0 to 255.
Violation if assignment is too low.
*/

void Foo()
{
        unsigned char uVal = 0;
        uVal = -1;
        // ...
        return;
}

/*
```

AssignmentOperator.rule

Declare an assignment operator for classes with pointer member variables

This rule checks whether you declare an assignment operator for classes with pointer member variables.

Reason for rule: Declaring an assignment operator for each class with pointer member variables prevents memory leaks and data corruption.

Note: This rule is similar to item ecpp_11.

Example

```
// See also ECPP 11
class A                    // Violation
{
public:
    A() {}
    ~A() {}
private:
    char *cptr1;
};
```

BaseDestructors.rule

Make destructors virtual for all base classes

This rule checks whether destructors in base classes are virtual.

Reason for rule: Making all destructors for base classes virtual prevents memory leaks and improper object destruction.

Note: This rule is similar to item ecpp_14.

Example

```
// See ECPP 14

class Base
{
public:
    Base() {}
    ~Base() {}                  // Violation
};

class Derived: public Base
{
public:
     Derived() {};
    ~Derived() {};
};
```

BitwiseInCondition.rule

Do not use the bitwise operator inside conditionals

This rule checks whether bitwise operators are inside conditionals.

Reason for rule: Using bitwise logical operators (`&`, `|`, or `~`) in the conditional part of `if`, `while` or `switch` can make code difficult-to-read and error-prone.

Example

```
int Foo (int iVar)
{
        if (iVar & 0x01) { // hit
                iVar += 10;
        } else {
                iVar -= 10;
        }
        return iVar;
}
```

BreakInForLoop.rule

Do not use break in for loops

This rule checks if there are `breaks` in your `for` loops.

Reason for rule: Avoiding `breaks` in the `for` loop makes your code easier to follow.

Note: This rule is similar to item ecpp_14.

Example

```
// Avoid break in for loop to make the code easier to follow.

void func() {
    for (int i = 0; i < 10; i++) {        // Okay
    }
    for (int i = 0; i < 10; i++) {        // Violation
        if (true) {
            break;
        }
    }
}
```

CastFuncPtrToPrimPtr.rule

Do not cast a pointer to a function to a pointer of primitive type

This rule checks whether pointers to functions are cast to pointers of primitive types.

Reason for rule: Casting pointers to functions to pointers of primitive types can make code error-prone.

Example

```
void Foo(char *ptrC)
{
    *ptrC = 0;
    return;
}

void f()
{
    void *ptrV = 0;
    void (*funPtr) (char*) = 0;
    funPtr = &Foo;
    ptrV = (void*)funPtr; // violation
    // ...
    return;
}
```

Output

Pointer

CastPointer

Do not cast pointers to non-pointers

This rule checks whether you cast a pointer to a non-pointer.

Reason for rule: Casting a pointer to a non-pointer results in a loss of typechecking.

Example

```
void func()
{
    int i;
    char * pchar = "hello";
    i = (int)pchar;          // Violation
}
```

CastUnsigned.rule

Do not cast an unsigned char to an unsigned int

This rule checks whether you cast an unsigned `char` to an unsigned `int`.

Reason for rule: Casting an unsigned `char` to an unsigned `int` can result in loss of precision.

Example

```
bool foo( char ch )
{
    if( (unsigned) ch == 0xFF ) {  // Violation
        return true;
    }
    return false;
}
```

CharacterTest.rule

Use the ctype.h facilities for character test

This rule checks whether you use the ctype.h facilities for character test.

Reason for rule: The ctype.h facilities for character tests and upper-lower conversions (isalnum, isalpha, iscntrl, isdigit, isgraph, islower, isprint, ispunct, isspace, isupper, isxdigit, tolower, toupper) are portable across different character code sets, are usually very efficient, and promote international flexibility. However, other similarly named functions (such as _tolower, _toupper, _isascii) are not universally portable.

Example

```
#include

void test(char c) {
   if( 'a' <= c && c <= 'z') { //Violation
   }
   if( islower(c) ) { //OK
   }

   while( 'A' <= c && c <= 'Z') { //Violation
   }
   while( isupper(c) ) { //OK
   }
}
```

CharCompare.rule

Do not compare chars to constants out of char range

This rule checks whether you compare `chars` to constants out of `char` range

Reason for rule: Comparing `chars` to constants out of `char` range can result in a constant out of range for the comparison operator.

Example

```
int foobar(char c)
{
   if (c > 300) { return 3;}  // Violation
   if (c > 25) { return 2;}  // OK
   return 0;
}
```

CommaOperator.rule

The comma operator shall only be used in for statements and variable declarations

This rule checks whether you use the comma operator in `for` statements and variable declarations.

Reason for rule: The comma operator shall only be used in `for` statements, variable declaration(s)/ definitions (s), and multi-statement preprocessor macro definition). Extensive use of the comma operator reduces readability.

Example

```
void foo(int i)
{
    int dVal,count; //OK
    foo((dVal=i,count=dVal+1)); //Violation
}
```

ConstParam.rule

Declare reference parameters as const references whenever possible

This rule checks if you declared your reference parameters as `const` references.

Reason for rule: When your function is not going to modify the argument it is referencing, you should use `const` to protect variables from unintended modifications when the function returns.

Example

```
struct Foo {
   int x;
   int y;
};

int Bar(Foo &f) {       // Violation
   return f.x;
}

int FooBar(Foo &f) {    // Okay
   return f.y++;
}
```

ConstPointerFunctionCall. rule

Const data type should be used for pointers in function calls if the pointer will not be modified

This rule checks whether you use `const` data types for pointers in function calls when the pointer will not be modified.

Reason for rule: The `const` specifier guarantees that the value of the variable cannot be changed. If the value is changed, the compiler will report an error.

Example

```
int foo( int *j) { // Violation
    return  *j;
}

int bar( const int *j) { // Okay
    return  *j;
}
```

DeclDimArray.rule

Don't declare the magnitude of an array declaration

This rule checks if you declare the magnitude of an array declaration.

Reason for rule: When arrays are initialized in the definition, their magnitude should be set by initialization. By allowing the magnitude of an array to be set automatically during definition, changes to the number of elements in the initialization list do not require corresponding changes to the explicit array size.

Example

```
#define SIZE 4

int tab1[SIZE] = {1,2,3}; //Violation
int tab2[]={1,2,3}; //OK
int tab3[SIZE] = {1,2,3}; //Violation
```

DeclareArrayMagnitude.rule

Don't declare the magnitude of a single dimensional array in the parameter declaration

This rule checks if you declare the magnitude of a single dimensional array in the parameters declaration.

Reason for rule: You should not declare the magnitude of a single dimensional array in the argument declaration; if you do, the 'C' language will pass an array argument as a pointer to the first element in the array. In fact, a different invocation of the function may pass array arguments with different magnitudes. Therefore, specifying magnitude of array in a function argument definition might only serve to hinder software maintenance.

Example

```
void foo1(int ii[]) { //OK
}

void foo2(int ii[30]) { //Violation
}

void foo3(char a,int ii[30][30][30]) { //Violation
}

void foo4(char a,int ii[][30][30]) { //OK
}
```

DeclareBitfield.rule

Do not declare member variables as bitfields

This rule checks if you declare member variables as bitfields.

Reason for rule: Informational.

Example

```
struct A
{
    int iVarBitField : 8;
    int iVar;
};
```

DeclareExplicitConstructor. rule

Do not use the keyword 'explicit' for a constructor

This rule checks if you use the keyword ‘explicit’ for a constructor.

Reason for rule: Informational.

Example

```
class X {
public:
   explicit X(int);
   explicit X(double) {}
};
```

DeclareMutable.rule

Do not declare member variables with the 'mutable' keyword

This rule checks if you declare member variables with the 'mutable' keyword.

Reason for rule: Informational.

Example

```
/*
   This rule is purely informational and will report a mes-
sage
   when a variable declaration with the 'mutable' keyword is
found.
*/

class Date{
public:
   int getMonth() const;       // A read-only function
private:
         mutable int month;
         int year;
         int day;
};

int Date::getMonth() const
{
         month++; // Doesn't modify anything if not mutable
         return month;

}
```

DeclareRegister.rule

Do not declare local variables with the 'register' keyword

This rule checks if you declare local variables with the 'register' keyword.

Reason for rule: Informational.

Example

```
void Foo()
{
   register int i = 0; // hit
   return;
}
```

DeclareStaticLocal.rule

Do not declare local variables with the 'static' keyword

This rule checks if you declare local variables with the 'static' keyword.

Reason for rule: Informational.

Example

```
void Foo()
{
    int static iVar = 9; // hit
    return;
}
```

DeleteIfNew.rule

Write operator delete if you write operator new

This rule checks whether you write operator `delete` when you write operator `new`.

Reason for rule: Writing operator `delete` and operator `new` in concert helps prevent memory corruption and memory leaks.

Note: This rule is similar to item ecpp10.

Example

```
// See ECPP 10

class A
{                                       // Violation
public:
    A() {}
    void* operator new(size_t size)
    {
        return new int[size];
    }
};
```

DeleteNonPointer.rule

Do not call delete on non-pointers

This rule checks whether you call `delete` on a non-pointer.

Reason for rule: Calling `delete` on a non-pointer results in an invalid operand.

Example

```
class Rhino {
public:
   Rhino();
   Rhino (char *);
   Rhino (const char *);
   operator char *();
};

void func()
{
   Rhino r;
   delete(r);  // Violation
}
```

DoWhile.rule

Prefer while statements over do statements

This rule checks whether your code prefers `while` statements over `do` statements.

Reason for rule: Using `do` statements can lead to errors and confusion. Using `while` statements instead of `do` statements can make code clearer and help prevent errors.

Example

```
do {
     i++;
} while ( i < 10);  // Violation

while (i < 10) {  // OK
     i++;
}
```

EnumKeyword.rule

Do not use the ‘enum’ keyword to declare a variable in C++

This rule checks whether your C++ code uses `enum` keywords to declare variables.

Reason for rule: Readability.

Example

```
// enum keyword is unnecessary in C++ when declaring
// a variable.
enum Colors { RED, BLUE, GREEN };
enum Colors c; // Violation, enum keyword is unnecessary
Colors c; // OK
```

EnumNamingConvention. rule

In an enumerated list, list members (elements) shall be in uppercase and names or tags for the list shall be in lowercase

This rule checks naming conventions in enumerated lists; it checks that list members (elements) are in uppercase and that tags for the list are in lowercase.

Reason for rule: The members of a list are equivalent to a defined constant; only the compiler is doing the definition.

Example

```
//OK
enum color {
    RED,
    BLUE,
    GREEN
};
//Violation
enum Color {
    red,
    blue,
    green
};
```

EqualityFloat.rule

Don't check floats for equality; check for greater than or less than

This rule checks whether you check `floats` for equality instead of checking for greater than or less than.

Reason for rule: If you check `floats` for equality, you make your code more susceptible to rounding errors.

Example

```
void func(float a, float b)
{
    if (a==b) { }     // Violation
    while (a!=b) { }  // Violation
    if (a>b) { }      // OK
}
```

ExplicitEnumValues.rule

When using enum, the values of each member should be explicitly declared

This rule checks if the values of each member are explicitly declared when you are using `enum`.

Reason for rule: Declaring values is useful as a documenting feature. Documenting is valuable when using an emulator, logic analyzer or other debugging device.

Example

```
enum my_enum
{
    a,      //Violation
    b = 3   //OK
};
```

ExplicitLogicalTest.rule

Use explicit logical tests in conditional expressions

This rule checks whether you use explicit logical tests in conditional expressions.

Reason for rule: Using explicit logical tests in conditional expressions improves code readability.

Example

```
void foo( int *j)
{
    if(!j){ // Violation
    }
    if(j!=0){ // OK
    }
}
```

ExprInSizeof.rule

Avoid expressions in the sizeof operator

This rule checks for expressions in the `sizeof` operator.

Reason for rule: Expressions in the `sizeof` operator will not be executed.

Example

```
void foo ()
{
    int iVar1 = 0;
    int iVar2 = 0;
    iVar1 = sizeof(iVar2 = 1); /* Violation */

    return;
}
```

FileNameConvention.rule

Use lowercase for file names

This rule checks whether your file names are in lowercase.

Reason for rule: When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

ForLoopVarAssign.rule

Don't assign to loop control variables in the body of a for loop

This rule checks whether you assign to loop control variables in the body of a `for` loop.

Reason for rule: `For` loop control variables should only be modified in the initialization and condition expressions of the `for` loop statement. Modifying them inside the body of the `for` loop makes the loop condition difficult to understand and points to a possible logical flaw in the code.

Example

```
void func() {
   for (int i = 0; i < 100; i++) {  // Violation
        i += 3;
   }
   for (int i = 0; i < 100; i++) {  // Violation
        i++;
   }
}
```

FractionLoss.rule

Don't assign the dividend of two ints to a float

This rule checks whether you assign the dividend of two `ints` to a `float`.

Reason for rule: Assigning a dividend of two `ints` to a `float` may cause a loss of fraction.

Example

```
void func()
{
   int a = 3;
   int b = 4;
   double d;
   d = a / b;            // Violation
   d = ((double)a) / b;  // OK
}
```

FuncModifyGlobalVar.rule

Avoid functions that modify the global variable

This rule checks whether functions modify the global variable.

Reason for rule: Informational.

Example

```
int theGlob;
// ...
void foo( int iVar )
{
    theGlob = -1;
    if (iVar == 0 )
         {
        theGlob = 0;
    } else {
        theGlob = 1;
    }
    return;
}
```

FunctionSize.rule

Avoid functions with over 50 lines

This rule checks whether functions have over 50 lines.

Reason for rule: Programs should be designed so that most of the functions will be less than 50 lines of source listening. Algorithms are easier to create and to understand if they are built of pieces small enough to be grasped as one concept.

GlobalPrefixExclude.rule

Global prefixes should only be used for global variables

This rule checks whether global prefixes are used with local variables.

Reason for rule: Using global prefixes for local variables reduces code readability.

Example

```
void foo()
{
    int theVar = 0;
    // ...
    theVar++;
    return;
}
```

GlobalVarFound.rule

Avoid global variables

This rule checks whether your code contains global variables.

Reason for rule: Informational.

Example

```
int theVar; // hit
// ...
void foo(int iVar)
{
   theVar = iVar;
   return;
}
```

HeaderInitialization.rule

Headers should not contain any initialization

This rule checks whether headers contain any initialization.

Reason for rule: Headers should not contain any initialization. When initialization is in the header, it is not clear which function "owns" the date (i.e., it doesn't localize the "defining instance"). Multiple source files each including a file containing initializations will generally produce "multiply defined" diagnostics.

IfAssign.rule

Avoid assignment in if statement condition

This rule checks whether your code has assignment within an `if` statement condition.

Reason for rule: Legibility and maintainability; assignment in the context of an `if` statement is easily confused with equality.

Example

```
// Assignment in the context of if statement is easily
// confused with equality.
void foo(int a, int b) {
   if ( a = b ) {}  // Violation
   if ( a == b ) {} // OK
}
```

IfElse.rule

All if statements should have an else clause

This rule checks if each of your `if` statements has an `else` clause.

Reason for rule: Writing `if` and `else` in concert improves readability and reliability.

Example

```
void Foo(bool b) {
  int i = 0;
  int j = 0;
  if (b) {       // Informational, should have an else clause
    i += j;
  }
  if (b) {
    j += i;
  } else {       // Okay, has an else clause
    i++;
  }
}
```

ImplicitUnsignedInit.rule

Do not initialize unsigned integer variables with signed constants

This rule checks if you initialize unsigned integer variables with signed constants.

Reason for rule: Numeric constants have a type. Use the appropriate suffix to avoid undesirable implicit cast.

Example

```
void foo()
{
    unsigned int x = 21;  /* Violation */
    unsigned int y = -21; /* Violation */
    unsigned int z = 21u; /* OK */

    return;
}
```

InitCharOutOfRange.rule

Avoid constants out of range for the char type

This rule checks for constants out of the legal range for the `char` type.

Reason for rule: The legal range of values of `char` type is -128 to 127.

Example

```
void Foo()
{
  char uVal = 157; // hit
  // ...
  return;
}
```

InitPointerVar.rule

Initialize all pointer variables

This rule checks if all of your pointer variables are initialized.

Reason for rule: Initializing pointer variables prevents dereferencing of uninitialized pointers.

Example

```
void foo() {
  int *i;           // Violation
  int *k = 0;       // Okay
}
```

InitCharOutOfRange.rule

Avoid constants out of range for the unsigned char type

This rule checks for constants out of the legal range for the unsigned char type.

Reason for rule: The legal range of values of char type is 0 to 255.

Example

```
void Foo()
{
  unsigned char uVal = 259; // hit
  // ...
  return;
}
```

LocalVariableNames.rule

Local variable names shall be proper lowercase

This rule checks whether local variable names are proper lowercase.

Reason for rule: By standardizing the appearance of variables, you can more easily differentiate user-defined variables from constants.

Example

```
void foo() {
    int Count; //Violation
    int date;  //OK
};
```

LongConst.rule

Use capital 'L' instead of lowercase 'l' to indicate long

This rule checks whether you use capital “L” instead of lowercase ‘l’ to indicate `long`.

Reason for rule: Using capital “L’ to indicate `long` increases readability and correctness.

Example

```
void func()
{
    int i = 0;
    i = 341;  // OK
    i = 34l;  // Violation
    i = 34L;  // OK
}
```

ManyCases.rule

Avoid switch statements with many cases

This rule checks whether your code contains `switch` statements with many `cases`.

Reason for rule: Using many `case` statements makes code difficult to follow. More importantly, `switches` with many `cases` often indicate places where polymorphic behavior could better be used to provide different behavior for different types. Note that although the general principle is to avoid many `cases` in a `switch`, the actual cutoff point is arbitrary.

Example

```
void foo(int i) {
      switch (i) {          // Violation
      case 1:
         break;
      case 2:
         break;
      case 3:
         break;
      case 4:
         break;
      case 5:
         break;
      case 6:
         break;
      case 7:
         break;
      case 8:
```

```
            break;
         case 9:
            break;
         case 10:
            break;
         case 11:
            break;
         default:
            break;
         }
   }
```

MetricBlockofCode.rule

Metric: Blocks of code per function

This metric measures the number of blocks of code in a function.

Reason for rule: “Code with many paths will be harder to understand and more likely to contain errors.” (from "A Practical Guide to Object-Oriented Metrics" by Mark Schroeder, IT Professional, November/December 1999, pg. 34)

Example

```
void func(int i} {
  if (1) {
     // do something;
  } else {
     // do another;
  }
  do {
  } while(1);
  switch(i) {
  case 1:
    break;
  default:
    break;
  }
}
```

MetricBreakEncap.rule

Metric: Global variables referenced in member functions

This metric measures the number of global variables referenced in your code's member functions.

Reason for rule: "Global references tend to break encapsulation and inhibit reuse. While global references may be difficult to eliminate entirely, they should be used as sparingly as possible." (from "A Practical Guide to Object-Oriented Metrics" by Mark Schroeder, IT Professional, November/December 1999, pg. 33)

Example

```
int globalVar = 1;
class Foo {
public:
  void func() {
     memberVar = GlobalVar;    // Violation, global var is
used here
  }
private:
  int memberVar;
};
```

MetricFuncCall.rule

Metric: Function calls per function

This metric measures the number of function calls in each function.

Reason for rule: “TFC [total function calls] tallies the number of calls to methods and system functions within the system, class, or method. This metric measures size in a way that is more independent of coding style than the LOC [lines of code] metric.” (from "A Practical Guide to Object-Oriented Metrics" by Mark Schroeder, IT Professional, November/December 1999, pg. 32)

Example

```
class Base {};
class Dev1 : public Base {};
class Dev2 : public Dev1 {};
```

MetricInheritance.rule

Metric: Class inheritance level

This metric measures the class inheritance level by calculating the number of base classes.

Reason for rule: “An unnecessarily deep class hierarchy adds to complexity and can represent a poor use of the inheritance mechanism.” (from "A Practical Guide to Object-Oriented Metrics" by Mark Schroeder, IT Professional, November/December 1999, pg. 33)

Example

```
class Base {};
class Dev1 : public Base {};
class Dev2 : public Dev1 {};
```

MetricMembers.rule

Metric: Data members per class

This metric measures the number of data members per class.

Reason for rule: “The number of attributes in a class indicates the amount of data the class must maintain in order to carry out its responsibilities.” (from "A Practical Guide to Object-Oriented Metrics" by Mark Schroeder, IT Professional, November/December 1999, pg. 33)

Examples

```
class Foo {
public:
    int i;
protected:
    int j;
private:
    int k;
};
```

MetricMethod.rule

Metric: Methods per class

This metric measures the number of methods per class.

Reason for rule: “The number of methods per class indicates the total level of functionality implemented by a class.” (from "A Practical Guide to Object-Oriented Metrics" by Mark Schroeder, IT Professional, November/December 1999, pg. 33)

Example

```
class Foo {
public:
  void method1();
protected:
  void method2();
private:
  void method3();
};
```

MetricParam.rule

Metric: Parameters per method

This metric measures the number of parameters in each method.

Reason for rule: “A high number of parameters indicates a complex interface to calling objects, and should be avoided.” (from "A Practical Guide to Object-Oriented Metrics" by Mark Schroeder, IT Professional, November/December 1999, pg. 34)

Example

```
class Foo {
public:
   // Violation so many parameters
   void func(int i, double d, float f, char c, Foo &);
};
```

MetricPrivateMembers.rule

Metric: Private members per class

This metric measures the number of private data members per class.

Reason for rule: “The number of attributes in a class indicates the amount of data the class must maintain in order to carry out its responsibilities.” (from "A Practical Guide to Object-Oriented Metrics" by Mark Schroeder, IT Professional, November/December 1999, pg. 33)

Examples

```
class Foo {
private:
    int k;
};
```

MetricPrivateMethod.rule

Metric: Private methods per class

This metric measures the number of private methods per class.

Reason for rule: “The number of methods per class indicates the total level of functionality implemented by a class.” (from "A Practical Guide to Object-Oriented Metrics" by Mark Schroeder, IT Professional, November/December 1999, pg. 33)

Examples

```
class Foo {
private:
    void method();
};
```

MetricProtectedMembers.rule

Metric: Protected members per class

This metric measures the number of protected data members per class.

Reason for rule: “The number of attributes in a class indicates the amount of data the class must maintain in order to carry out its responsibilities.” (from "A Practical Guide to Object-Oriented Metrics" by Mark Schroeder, IT Professional, November/December 1999, pg. 33)

Examples

```
class Foo {
protected:
    int j;
};
```

MetricProtectedMethod.rule

Metric: Protected methods per class

This metric measures the number of protected methods per class.

Reason for rule: “The number of methods per class indicates the total level of functionality implemented by a class.” (from "A Practical Guide to Object-Oriented Metrics" by Mark Schroeder, IT Professional, November/December 1999, pg. 33)

Examples

```
class Foo {
protected:
    void method();
};
```

MetricPublicMembers.rule

Metric: Public members per class

This metric measures the number of public data members per class.

Reason for rule: “The number of attributes in a class indicates the amount of data the class must maintain in order to carry out its responsibilities.” (from "A Practical Guide to Object-Oriented Metrics" by Mark Schroeder, IT Professional, November/December 1999, pg. 33)

Examples

```
class Foo {
public:
    int i;
};
```

MetricPublicMethod.rule

Metric: Public methods per class

This metric measures the number of public methods per class.

Reason for rule: “The number of methods per class indicates the total level of functionality implemented by a class.” (from "A Practical Guide to Object-Oriented Metrics" by Mark Schroeder, IT Professional, November/December 1999, pg. 33)

Examples

```
class Foo {
public:
    void method();
};
```

ModifyInCondition.rule

Do not use operator ++ or -- in the conditional part of if, while, or switch

This rule checks whether you use operator `++` or `--` in the conditional part of `if`, `while`, or `switch`.

Reason for rule: Using the operator `++` or `--` in the conditional part of `if`, `while`, or `switch` can make code difficult-to-read and error-prone .

Example

```
int Foo (int iVar)
{
    if (iVar-- && iVar<10) { // hit
        iVar += 10;
    } else {
        iVar -= 10;
    }
    return iVar;
}
```

NameBool.rule

Begin all boolean type variables with 'b'

This rule checks whether all of your boolean type variables begin with ‘b’.

Reason for rule: Hungarian notation. When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
void foo() {
  bool Var; // Violation
  bool bVar;  // OK
}
```

NameClass.rule

Begin class names with an uppercase letter

This rule checks whether each class name begins with an uppercase letter.

Reason for rule: When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
class foo {}; // Violation
class Foo {}; // OK
```

NameConflict.rule

Avoid internal or external name conflict

This rule checks for internal or external name conflict.

Reason for rule: Internal or external name conflicts with a C++ reserved word will cause problems if the program is compiled with a C compiler. Most C compilers do not detect naming conflicts, so name conflicts can can lead to unpredictable program behavior.

Example

```
int bool  = 0;
int catch = 0;
int class = 0;
int const_cast = 0;
int delete = 0;
int dynamic_cast = 0;
int explicit = 0;
int export = 0;
int false = 0;
int friend = 0;
int inline = 0;
int mutable = 0;
int namespace = 0;
int new = 0;
int operator = 0;
int private = 0;
int public = 0;
int protected = 0;
int reinterpret_cast = 0;
```

```
int static_cast = 0;
int template = 0;
int this = 0;
int throw = 0;
int true = 0;
int try = 0;
int typeid = 0;
int typename = 0;
int using = 0;
int virtual = 0;
int wchar_t = 0;
```

NameConstantVar.rule

Begin constant variables with ‘c’

This rule checks whether each constant variable begins with ‘c’.

Reason for rule: When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
// Constant variable names begin with 'c'
const int Foo = 0; // Violation
const int cFoo = 0; // OK
```

NameDataMember.rule

Begin class data member names with ‘its’

This rule checks if your class data member names begin with ‘its’.

Reason for rule: When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
class Foo {
private:
    int bar;     // Violation
    int itsBar  // OK
};
```

NameDouble.rule

Begin all double type variable with 'd'

This rule checks whether all of your `double` type variables begin with ‘d’.

Reason for rule: Hungarian notation. When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
void foo() {
  double Var;   // Violation
  double dVar;  // OK
}
```

NameEnumType.rule

Begin enumerated type names with an uppercase letter that is prefixed by the software element and suffixed by '_t'

This rule checks whether the name of each enumerated type begins with an uppercase letter, is prefixed by the software element, and is suffixed by '_t'

Reason for rule: When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
// The names of abstract data types shall begin with an
// uppercase, prefixed by software element and suffixed by
// '_t'.
enum LOC_PossibleColors_t { RED, BLUE, GREEN }; // Violation
enum LOC_PossibleColors { RED, BLUE, GREEN }; // OK
```

NameFloat.rule

Begin all float type variables with 'f'

This rule checks whether all of your `float` type variables begin with ‘f’.

Reason for rule: Hungarian notation. When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
void foo() {
  float Var;   // Violation
  float fVar;  // OK
}
```

NameFunction.rule

Begin all function names with an uppercase letter

This rule checks whether each function name begins with an uppercase letter.

Reason for rule: When an entire development group agrees on a common convention, code becomes easier to read and understand.

Example

```
void foo(); // Violation
void Foo(); // OK
```

NameGlobalVar.rule

Begin global variable names with ‘the’

This rule checks whether each global variable name begins with “the”.

Reason for rule: When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
int global_var; // Violation
int theWindows; // OK
```

NameInt.rule

Begin all integer type variable with 'i'

This rule checks whether all of your integer type variables begin with ‘i’.

Reason for rule: Hungarian notation. When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
void foo() {
  int Var;   // Violation
  int iVar;  // OK
}
```

NameIsFunction.rule

Begin ‘is’ function names with bool values

This rule checks if your ‘is’ function names begin with `bool` values.

Reason for rule: Beginning ‘is’ function names with `bool` values improves legibility and clarifies what the return value means.

Example

```
int isPos(int x) {        // Violation
    return x > 0;
}

bool isPositive(int x) {  // Okay
    return x > 0;
}
```

NameLongInt.rule

Begin all long integer variables with 'li'

This rule checks whether all of your `long` integer variables begin with ‘li’.

Reason for rule: Hungarian notation. When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
void foo() {
  long int Var;    // Violation
  long int liVar;  // OK
}
```

NamePointerVar.rule

Prefix variable type pointer names with ‘p’

This rule checks if your variable type pointer names begin with ‘p’.

Reason for rule: When you add a prefix of a type to a variable, the code will be more legible and you will prevent many bugs.

Example

```
int *Foo; // Violation
int *pFoo; // OK
```

NameShortInt.rule

Begin all short integer variables with 'si'

This rule checks whether all of your `short` integer variables begin with ‘si’.

Reason for rule: Hungarian notation. When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
void foo() {
  short int Var;    // Violation
  short int siVar;  // OK
  short Violation;  // Violation
  short siOkay;     // OK
}
```

NameSignedChar.rule

Begin all signed character variables with 'c'

This rule checks whether all of your signed character variables begin with ‘c’.

Reason for rule: Hungarian notation. When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
void foo() {
  unsigned char Var;    // Violation
  unsigned char ucVar;  // OK
}
```

NameString.rule

Begin all terminated characters' string variables with 'sz'

This rule checks whether all of your terminated characters' string variables begin with 'sz'.

Reason for rule: Hungarian notation. When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
void foo() {
  char Var[] = "\n"; // Violation
  char szVar[] = "\n";  // OK
}

}
```

NameStructType.rule

Begin struct type names with an uppercase letter that is prefixed by a software element and suffixed by ‘_t’

This rule checks the prefixes, suffixes, and first letters of your `struct` type names.

Reason for rule: When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
struct LOC_Position { }; // Violation
struct LOC_Position_t {} // OK
```

NameUnsignedChar.rule

Begin all unsigned character type variables with 'uc'

This rule checks whether all of your `unsigned` character type variables begin with ‘uc’.

Reason for rule: Hungarian notation. When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
void foo() {
  unsigned char Var;    // Violation
  unsigned char ucVar;  // OK
}
```

NameUnsignedInt.rule

Begin all unsigned integer type variables with ‘ui’

This rule checks whether all of your `unsigned` integer type variables begin with ‘ui’.

Reason for rule: Hungarian notation. When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
void foo() {
  unsigned int Var;    // Violation
  unsigned int uiVar;  // OK
}
```

NameVariable.rule

Begin variable names with a lowercase letter

This rule checks if your variable names begin with a lowercase letter.

Reason for rule: When an entire development group agrees on a common convention, code becomes easier to read and more easily understood.

Example

```
void foo() {
    int Local_var; // Violation
    int local;  // OK
}
```

NamingStructUnion Members.rule

Use lowercase letters for structure and union member names

This rule checks whether you use lowercase letters for structure and union member names.

Reason for rule: Using lowercase letters for structure and union member names will make it easier to recognize structure/union members.

Example

```
//OK
struct date_foo1 {
    int dateMonth;
    int dateDay;
    int dateYear;
};

//Violation
struct date_foo2 {
    int datemonth;
    int DateDay;
    int Dateyear;
};
```

NonScalarTypedefs

Append names of non-scalar typedefs with "_t".

Reason for rule: Following this convention will make it easier to recognize user-defined data types and maintain the software.

Example

```
class MyClass {
   int count;
};

typedef MyClass My_t;   //OK
typedef MyClass My;    //Violation
```

NumberFunctionParam.rule

Avoid functions with more than 5 parameters

This rule checks for functions with more than 5 parameters.

Reason for rule: Avoiding functions with more than 5 parameters will reduce the amount of coupling between functions. If more parameters are needed, a structure could be used to hold related data and a pointer could be passed.

Example

```
void foo(int a, int b, int c, int d, int e, int f) // Viola-
tion
{
}
```

OpEqualThis.rule

Return reference to *this in operator= functions

This rule checks whether you return reference to `*this` in `operator=` functions.

Reason for rule: Returning reference to `*this` in `operator=` functions protects you from not knowing where the temporary gets destroyed and allows you to declare the `operator=`'s parameter as a reference to `const`, which is safer than just declaring it to be a reference.

Note: This rule is similar to item ecpp_15.

Example

```
// See ECPP 15

class A
{
public:
    explicit A(int i = 0) : _i(i) {}
    void operator=(const A& a)             // violation
    {
        if (&a == this) {
            return;
        }
        int _i = a._i;
        return;
    }
private:
    int _i;
};
```

PassByValue.rule

Pass arguments of built-in types by value unless they should be modified by functions

This rule checks if your code passes arguments of built-in types by value, unless they should be modified by functions.

Reason for rule: Passing arguments of built-in types by value improves the efficiency of your code.

Example

```
int Foo(int i, int &j) {      // Violation
    return i + j;
}

int Bar(int i, int &j) {      // Okay
    j += i;
    return j;
}
```

PointerParamDereference. rule

Don't dereference possibly null pointer parameters

This rule checks if you dereference possibly null pointer parameters.

Dereferences of possibly null pointers may be protected by conditional statements or assertions that check that the pointer is not NULL. This rule reports all functions which are passed pointers.

Reason for rule: A dereferenced null pointer is a common cause of program failures.

Example

```
void Foo (int *ptr1, char *ptr2, float *ptrF)
{
    *ptr1 = 10; // possibly null pointer dereference
    ptr2 = 0;
    if( ptrF==0) {
        return;
    }
    *ptrF = 0; // OK
    return;
}
```

PublicInterface.rule

Avoid member variables in the public interface

This rule checks whether your code's public interface contains member variables.

Reason for rule: Legibility and maintainability.

Example

```
class Foo {
public:
   int i;    // Violation
};
class Foo {
private:
   int i;    // OK
};
```

ReferenceInitialization.rule

Do not initialize a reference to refer to an object whose address can be changed

This rule checks whether you initialize a reference to refer to an object whose address can be changed.

Reason for rule: The reference to an object in the free store can be deleted via a pointer, and consequently can refer to an object with a null address.

Example

```
void foo()
{
   int *ptr = 0;

   int &rptr = *ptr; //Violation


   // assignment through null
   rptr = 10;
}
```

SingularSwitchStatement. rule

Avoid switch statements with only one case

This rule checks for `switch` statements with only one `case` statement.

Reason for rule: `switch` statements with only one `case` statement could be described using an `if` statement.

Example

```
void foo ()
{
    int i = 0;
    /*
    ...
    */
    switch(i) /* Violation */
    {
        case 0:  break;
        default:  break;
    }

    return;
}
```

SourceFileSize.rule

Avoid source files that are longer than 500 lines

This rule checks for source files that are longer than 500 lines.

Reason for rule: Larger files are more difficult to edit and maintain than smaller files.

SourceNamingConvention. rule

Use the ".c" extension for names of source files

This rule checks whether C source files use the “.c” extension.

Reason for rule: This convention is common practice and is mandated by some compilers.

StructKeyword.rule

Do not use the ‘struct’ keyword to declare a variable in C++

This rule checks whether your C++ code uses `struct` keywords to declare a variable.

Reason for rule: Using the `struct` keyword to declare a variable improves code readability.

Example

```
// struct keyword is unnecessary in C++ when declaring a
// variable.
struct Position_t {}
struct Position_t Pos1;  // Violation
Position_t Pos2;         // OK
```

ThrowDestructor.rule

Do not throw from within destructor

This rule checks whether you throw from within a destructor.

Reason for rule: Throwing from within a destructor may lead to memory leaks and improper object destruction.

Example

```
class Foo
{
public:
   Foo() {}
   ~Foo() {         // Violation
      throw;
   }
};
```

TooManyFields.rule

Avoid structs, unions, or classes with more than 20 fields

This rule checks whether structs, unions, or classes have more than 20 fields.

Reason for rule: Informational.

Example

```
struct _tA
{
    int i0;
    int i1;
    int i2;
    int i3;
    int i4;
    int i5;
    int i6;
    int i7;
    int i8;
    int i9;
    int i10;
    int i11;
    int i12;
    int i13;
    int i14;
    int i15;
    int i16;
    int i17;
    int i18;
```

```
    int i19;
    int i20; // more than 20
    int i21;
    int i22;
    int i23;
};
```

UnionFieldNotDefined.rule

Define fields for union declarations

This rule checks for union declarations that do not have any defined fields.

Reason for rule: Informational.

Example

```
union UNKNOWN // hit
{
};
```

UnnecessaryCast.rule

Avoid unnecessary casts

This rule checks if your code contains unnecessary casts.

Reason for rule: It is not necessary to explicitly upcast to a base class. Removing unnecessary casts makes code easier to read.

Example

```
class Base { /* ... */ };
class Derived : public Base { /* ... */ };
void Func() {
   Derived *d = new Derived();
   Base *b = (Base *)d;         // Violation
   Base *b1 = d;                // Okay
}
```

UnnecessaryEqual.rule

Avoid unnecessary “==true”s

This rule checks if your code contains unnecessary “==true”s.

Reason for rule: Checking bool expression equality with `true` is unnecessary. Removing unnecessary "`== true`"s increases legibility and efficiency.

Example

```
bool ret() {
  return true;
}

bool ret2() {
  return ret() == true;   // Violation  == is unnecessary.
}
```

UnreachableCode.rule

Do not use unreachable code

This rule checks for unreachable code in an `if` statement.

Reason for rule: Informational.

Example

```
void foo ()
{
    int i = 0;

    /*
    ...
    */

    if(1) /* Violation */
    {
        i = 1;
    } else {
        i = 2;
    }

    return;
}
```

UnusedLocalVariable.rule

Avoid unused local variables

This rule checks whether any of the declared local variables were not used.

Reason for rule: Eliminating unused local variables increases efficiency and legibility.

Example

```
void func() {
  int i = 0;    // Possible violation i is declared but not
used
}
```

UnusedParameter.rule

Avoid unused parameters

This rule checks for unused parameters.

Reason for rule: Eliminating unused parameters improves legibility and increases efficiency.

Example

```
int Foo(int i, int k) {      // Violation, k is not used.
    i = 5;
    return i;
}

int Bar(int i, int j) {      // Okay
    i += j;
    return i;
}
```

UnusedPrivateMember.rule

Avoid unused private member variables

This rule checks for unused private member variables.

Reason for rule: Eliminating unused private member variables improves legibility and increases efficiency.

Example

```
class Foo {
public:
    Foo(): x(0), y(0) { }
    int getX() {
        return x;
    }
private:
    int x;
    int y;         // Violation, y is declared but not used.
};
```

UsePositiveLogic.rule

Use positive logic rather than negative logic whenever practical

This rule checks for use of negative logic.

Reason for rule: The use of many logical nots "!" within an expression makes the expression difficult to understand and maintain.

Example

```
void foo( int *j) {
    if(j!=0){ //Violation
        (*j)++;
    }
    if(j==0){
    } else { //OK
        (*j)++;
    }
}
```

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